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AUTO ION STEERING COMMITTEE

KALAMAZOO, MICHIGAN

FINAL

FEASIBILITY STUDY ^{K.08} 11/193

FOR OPERABLE UNIT II

AUTO ION SITE

KALAMAZOO, MICHIGAN

THIS FINAL FEASIBILITY STUDY REPORT FOR OPERABLE UNIT II AT THE AUTO ION SUPERFUND SITE ALSO INCLUDES A MARCH 4, 1994, LETTER FROM U.S. EPA THAT MODIFIES SECTIONS OF THIS REPORT. THIS FEASIBILITY STUDY REPORT IS NOT CONSIDERED COMPLETE UNLESS THIS LETTER IS ATTACHED.

PROJECT #684-03

November 1993

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
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MAR 04 1994

REPLY TO THE ATTENTION OF:
(HSRW-6J)

Mr. Edward C. Burk, Jr.
Eder Associates Consulting Engineers
1st National Building, 3rd Floor
201 S. Main Street
Ann Arbor, Michigan 48104

RE: Comments and Modifications to Final FS Report, Operable Unit II,
Auto Ion Chemicals Superfund Site
Kalamazoo, Michigan

Dear Mr. Burk:

U.S. EPA and MDNR have completed reviews of the final Feasibility Study (FS) Report for Operable Unit II (OUII) at the Auto Ion Site. Because the final FS Report as submitted by the Auto Ion Steering Committee did not complete all changes to the FS according to U.S. EPA's October 8, 1993 set of comments, U.S. EPA is modifying the report in order to finalize this document. The list of U.S. EPA modifications to the OUII FS Report are attached. With these modifications, the FS Report for OUII is now considered final and will be released for public review.

Also attached for your review are the MDNR comments on the Final FS Report and U.S. EPA's responses to these MDNR comments. U.S. EPA is providing you with these comments for your information only. U.S. EPA is not requiring the Auto Ion Steering Committee to modify the OUII FS Report in accordance with the MDNR comments that U.S. EPA has decided not to address in the final FS Report.

If you have any questions regarding these modifications, please feel free to contact me at 312/886-4663.

Sincerely,

Michael McAteer
Remedial Project Manager

cc: Wendy Carney, USEPA w/o enclosures
Nancy-Ellen Zusman, USEPA w/o enclosures
Mary Geitka, MDNR w/o enclosures
David Nunn, Eastman & Smith



**UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5**

**U.S. EPA FINAL MODIFICATIONS TO THE OPERABLE UNIT II FEASIBILITY
STUDY REPORT, AUTO ION CHEMICALS SUPERFUND SITE
KALAMAZOO, MICHIGAN**

1. The Auto Ion Steering Committee has failed to provide documentation of the "administrative controls" already in place that would prevent the use of groundwater as a drinking water source at the Auto Ion Site in the future. The copy of a blank permit application in Appendix M provides no information relating to these "administrative controls." Page 47 of the FS Report states that the City of Kalamazoo "uses a set of criteria..." however, this set of criteria has not been provided to U.S. EPA as requested. Page 137 also states that the City of Kalamazoo "already enforces an ordinance which controls the installation of wells..." the Auto Ion Steering Committee has also failed to provide U.S. EPA with this ordinance.

U.S. EPA still believes that it would be highly unlikely that the groundwater beneath the Auto Ion Site would be used as a drinking water source because of its documented levels of contamination and its location near two Act 307 sites. This groundwater also exceeds Federal Safe Drinking Water standards for sodium and the Site is located within a 100-year floodplain, which would preclude the installation of wells in this location. Nevertheless, because there is no documentation in the FS of these "administrative controls," all alternatives (except the "No Action" alternative) described in the FS Report must also include deed restrictions to further prevent the use of groundwater from beneath the Site as a drinking water source. These deed restrictions would be filed with the Kalamazoo County Recorder of Deeds and would remain with the property until U.S. EPA determines that the groundwater no longer poses a risk to human health.

2. The Auto Ion Steering Committee has failed to remove all statements in the FS Report that describe a 5-year implementation delay or postponement when describing the remedial alternatives. As stated in U.S. EPA's October 8, 1993 list of comments on the OUII FS Report, there would be no justification for waiting 5 year before implementing an action if U.S. EPA were to select one of the active groundwater treatment systems as a final remedy for groundwater.

Therefore, all active remediation alternatives described in this FS Report must include the fact that they would be implemented immediately following U.S. EPA's design approval. There would be no implementation delay.

3. The FS Report includes incorrect Michigan Act 307 Type B values. A number of the Type B values have been updated since the FS was last revised. U.S. EPA has attached a list of the updated Type B values to this list of modifications. This updated list also includes updated Act 245, Rule 57 Groundwater-Surface Water Interface values. These updated Type B values and Rule 57 values should be referred to when comparing the levels of contaminants in groundwater at the Auto Ion Site to Act 307 and Act 245, Rule 57 standards.

Also, MDNR now uses standard default values under Act 307 Type C. These Type C values apply to "industrial" sites. A list of these Type C values has also been attached to this list of modifications. These standard Type C default values should be referred to when comparing the levels of contaminants in groundwater at the Auto Ion Site to Act 307 standards. The FS Report also states that specific remedial alternatives already meet Act 307 Type C cleanup criteria. This statement is only true when one compares the levels of contamination in groundwater at the Site to the Type C values proposed by the PRPs. It must also be noted that the levels of contamination in groundwater at the Site exceed most of the standard Type C default values as recently established by MDNR.

4. The FS Report repeatedly states: "It is estimated that it would take approximately 50 to 60 years for natural attenuation to potentially achieve MDNR Type B cleanup levels." This fact is based on the desorption rate for nickel (Appendix F). The Removal Time Frame Analysis (Appendix F) used a nickel cleanup standard of 100 ppb, which is the Maximum Contaminant Level (MCL) as derived by U.S. EPA, not the less stringent MDNR Type B cleanup level of 530 ppb. Based on the desorption rate of nickel, it would require approximately 20 to 30 years to attain this Type B cleanup level. Therefore, the FS Report should more accurately state that it may require 50 to 60 years for natural attenuation to potentially achieve cleanup levels, using either Act 307 cleanup levels or MCLs (which ever is more stringent).

It should also be noted that it would take approximately 15 to 20 years for natural attenuation to potentially achieve MDNR Type C cleanup levels, based on the desorption rate for nickel and the Type C nickel cleanup level of 1,600 ppb. In order for nickel to potentially achieve the Michigan Act 245, Rule 57 cleanup level of 57 ppb (through natural attenuation) it would require approximately 70 years.

5. The FS Report includes statements that describe termination of active remediation when an asymptotic point of recovery is reached. These statements should have been removed by the Auto Ion Steering Committee in accordance with U.S. EPA's October 8, 1993 comments.

Termination of any active remediation will be done after achievement of cleanup standards and demonstration that these standards can be maintained or when U.S.

EPA, in consultation with MDNR, makes a determination to terminate the remediation.

6. **PAGE 103, FIRST FULL PARAGRAPH:** The statement that Michigan Act 64 is more stringent than RCRA and therefore Act 64 will be considered the potential chemical-specific ARAR in lieu of RCRA is incorrect. Because elements of Act 64 are more stringent than RCRA does not mean that RCRA is not an ARAR. The FS Report is modified to state that both Michigan Act 64 and RCRA are ARARs for the Auto Ion Site.
7. **PAGE 103, THIRD FULL PARAGRAPH:** The statement that Michigan Water Resources Commission Act ("WRC" - Act 245) rules are at least as stringent as the Federal Clean Water Act (CWA) requirements therefore, only Michigan's WRC will be considered an ARAR, is incorrect. Because elements of Michigan's WRC are more stringent than the CWA does not mean that the CWA is not an ARAR. The FS Report is therefore modified to state that both Michigan's WRC and the Federal CWA are ARARs for the Auto Ion Site.
8. **PAGE 114, SECTION 2.6.4, SECOND SENTENCE:** This sentence is modified to read: "This requirement is not an ARAR as no remedial activities will adversely affect the Kalamazoo River."



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November 4, 1993
File #684-03

Michael McAteer
CERCLA Remedial Project Manager
United States Environmental Protection Agency
HSRW-6J
77 West Jackson Boulevard
Chicago, Illinois 60604

Re: Auto Ion Operable Unit II Feasibility Study Report

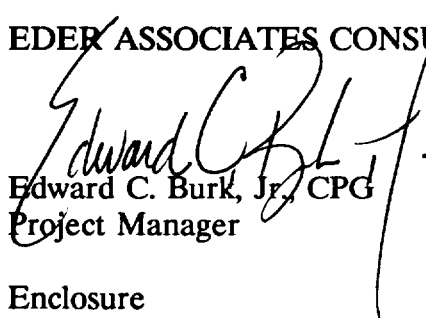
Dear Mr. McAteer:

On behalf of the Auto Ion PRP Committee, we are submitting the final Operable Unit II Feasibility Study for the Auto Ion site. This final incorporates your comments transmitted to the Committee on October 8, 1993.

Please call me if you have any questions.

Very truly yours,

EDER ASSOCIATES CONSULTING ENGINEERS, P.C.


Edward C. Burk, Jr., CPG
Project Manager


William M. Warren
Vice President

Enclosure
EB/cc

#CC1103.MM

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EXECUTIVE SUMMARY

The Auto Ion Operable Unit II Feasibility Study (FS) is limited to the evaluation of remedial alternatives for groundwater. Shallow groundwater at the site has been impacted primarily with several metals and volatile organic compounds (VOCs). This site is located in an older industrial portion of the City of Kalamazoo which is supplied with city water. Industrial properties adjacent to the site are potential sources of continuing groundwater contamination. The groundwater discharges from the site into the adjacent Kalamazoo River. The river flow is so large compared to the groundwater flow that any mixing zone would be virtually unmeasurable. The Baseline Risk Assessment determined that there are no significantly impacted receptors for the groundwater.

Operable Unit I involves soil excavation at the site which would eliminate the only remaining source of groundwater contamination at the Auto Ion site. Once implemented, natural attenuation is expected to flush residual constituents out of the groundwater improving its quality over time.

The Remedial Action Objectives (RAOs) for the site have been determined to be in compliance with MDNR Act 307. Conditions at the site already meet Act 307 Type C (site-specific) cleanup criteria. It is uncertain whether any remedial alternative may eventually meet all Type B (non site-specific) criteria. Although those remedial alternatives evaluated which intercepts groundwater before it reaches the Kalamazoo River may meet Type B criteria for the discharge of groundwater to surface water.

Various remedial technologies, process options, and initial alternatives were developed and screened based on effectiveness, implementability and cost. Four remedial alternatives were retained for detailed evaluation: No Further Action, Natural Attenuation/ Institutional Controls, a low flow pump and treatment system and a high flow pump and treatment system. These four remedial alternatives were evaluated and compared based on the nine criteria specified in the National Contingency Plan.

It was determined that all of the alternatives are protective of human health and the environment and that all of the alternatives would take an approximately equivalent time period to implement. Due to site-specific geology and constituents with high retardation factors, it appears that active pump and treatment alternatives would not be capable of achieving Type B cleanup levels sooner than by natural attenuation. In fact, none of the alternatives may be able to attain Type B cleanup levels. Each of the alternatives have an equal chance of eventually attaining Type B cleanup levels, if possible. Alternatives which extract contaminated groundwater before it reaches the river, may be more protective of human health and the environment than those that do not; however, the marginal increase in protectiveness would not be worth the cost of the extraction and treatment of groundwater. In addition, the time and energy associated with extraction and treatment of groundwater would generate secondary waste (spent carbon), requiring further treatment and disposal. Type C cleanup levels are already being met.

The only substantial difference between the alternatives was cost. The No Further Action alternative has no cost. The two pump and treatment alternatives are approximately ten and twelve times higher in cost than the Institutional Controls/Natural Attenuation alternative. Although the pump and treatment alternatives may stop the flow of contaminants to the river, the level of any increased protectiveness would be marginal. This is demonstrated in the approved Sediment Toxicity Evaluation Report (dated March 1993). The report concluded that there would not be a measurable effect on the river water quality due to groundwater at the Auto Ion Site.

1.0 INTRODUCTION

1.1 Purpose

The purpose of this Feasibility Study (FS) report is to document the basis and procedures used in identifying, developing, screening, and evaluating remedial alternatives which address impacted groundwater at the Auto Ion site. The objective of this report is to provide sufficient data to select the best remedial alternative that, based on standard criteria, protects human health and the environment from impacted groundwater.

This FS report is comprised of eight sections. Section 1.0, the Introduction, summarizes the site background information; the nature and extent of impacted groundwater; the fate and transport of residual chemicals; and baseline risk assessment; and, the uncertainties related to groundwater impact.

Section 2, The Identification of ARARs, defines ARARs; and discusses the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) requirements to satisfy other environmental regulations. It lists potentially applicable, relevant and appropriate requirements (ARARs); discusses these requirements; and, identifies those which are pertinent to this FS.

Section 3, the Identification and Screening of Remedial Technologies, presents the development of general response actions and remedial action objectives; identifies and presents a brief description of potentially applicable remedial technologies; evaluates each of these technologies with regard to effectiveness; and, presents the results of the screening evaluation.

Section 4, the Identification and Screening of Process Options, breaks down each potentially applicable remedial technology into process options; presents a brief description of each process

option; evaluates each of these process options with regard to effectiveness, implementability, and cost; and, present the results of this screening evaluation.

Section 5, the Development of Alternatives, presents the remedial alternatives developed by combining the technologies and process options identified in the previous screening sections.

Section 6, the Screening of Alternatives, narrows the list of alternatives developed in Section 5 by an initial screening of remedial alternatives with regard to effectiveness, implementability, and cost based on preliminary cost estimates. The results of this initial screening of alternatives are presented.

Section 7, the Detailed Evaluation of Alternatives, presents a detailed description of each alternative that passed the initial screening. In addition, a detailed evaluation of each remedial alternative is given with respect to seven criteria: 1) Overall protection of human health and the environment; 2) compliance with applicable or relevant and appropriate requirements; 3) long-term effectiveness and permanence; 4) reduction in toxicity, mobility, and volume; 5) short term effectiveness; 6) implementability; and, 7) cost.

Section 8, the Comparative Analysis, compares the alternatives evaluated in Section 7, in a summary format, using the same seven evaluation criteria.

This FS has included only those technologies which are potentially applicable to the groundwater at the Auto Ion site, and which can adequately protect human health and the environment in a cost effective manner. The FS specifically excludes site remedies that are based upon technologies that are obviously not relevant to the site, technologies that cannot be applied at the site because of physical constraints, and technologies that represent an order of magnitude higher cost than competing technologies without providing improved remedial performance over competing technologies.

1.2 Background Information

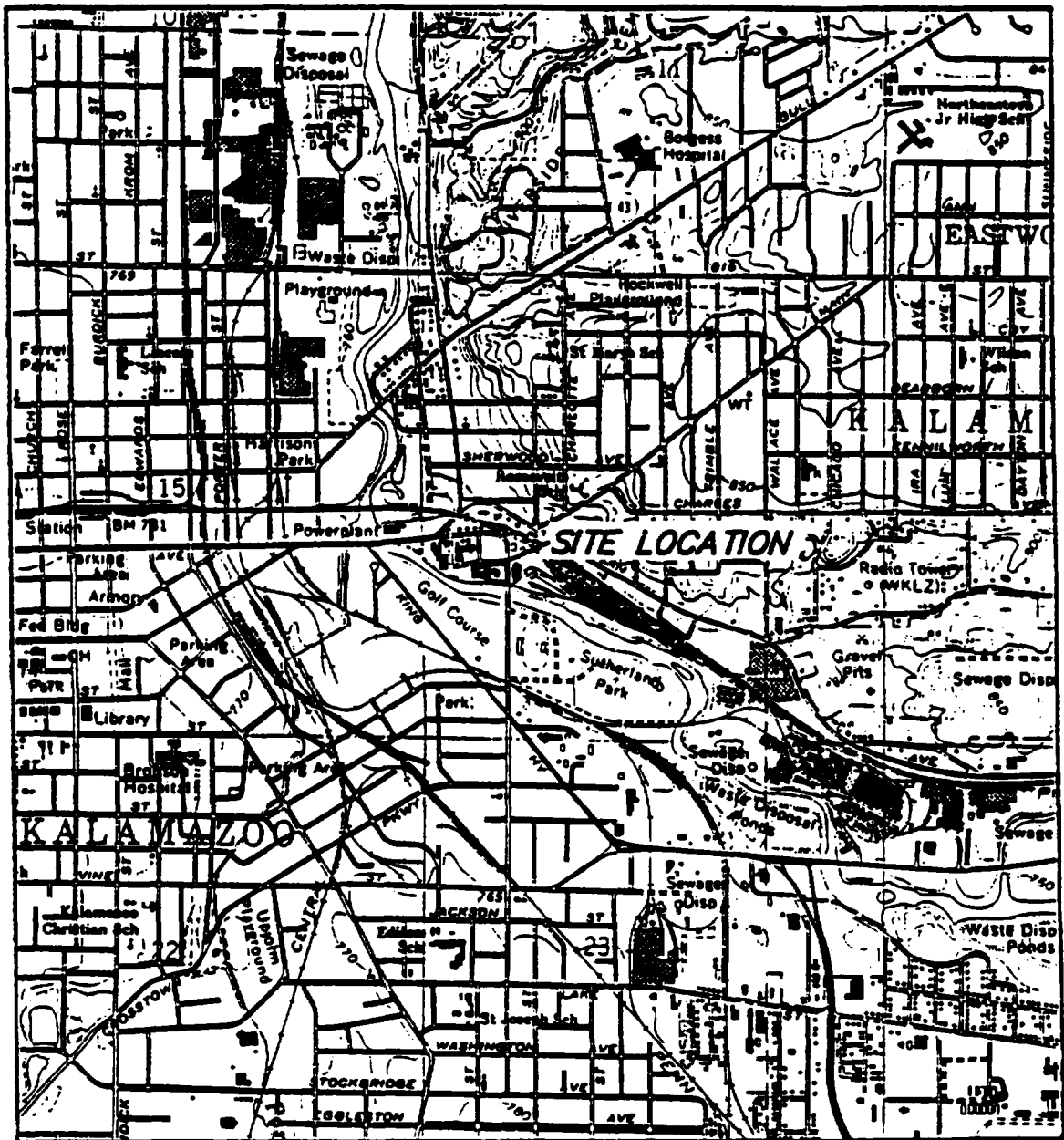
1.2.1 Site Description

The site is located at 74 Mills Street in a commercial/industrial district of northeast Kalamazoo, Michigan. The site occupies approximately 1.5 acres of fenced land adjacent to the Kalamazoo River in the 100 year floodplain (see Figure 1-1). The only remaining structure on the property is a flat cement slab foundation. The site is bordered to the north by O'Neil Street, to the east by Mills Street, to the south by the Kalamazoo River, and to the west by the Production Painting Company, an abandoned painting facility. The site is located in an old industrial area. A large Conrail railroad yard is located east of the site across Mills Street (see Figure 1-2).

The population of Kalamazoo, Michigan was reportedly 80,277 according to the 1990 census. The nearest residence is located approximately 500 feet north of the site along Mills Street. However, there are several businesses located within a 500 foot radius of the site. The site and surrounding area is serviced by city water and sewerage. The state and county health departments restrict the installation of drinking water wells in this area, because, among other reasons, city water is readily available.

Institutional and/or administrative controls that prevent the use of groundwater at the Auto Ion site are already in place. They include state and county health department's restrictions on the installation of wells which includes Act 399, P.A., Michigan Safe Drinking Water Act, and the City of Kalamazoo's water supply system well site selection criteria and expansion plans. A copy of a permit application for well installation (county) is included in Appendix M. In addition to these administrative controls, the city municipal water supply system has been expanded to service the entire area near the Auto Ion site.

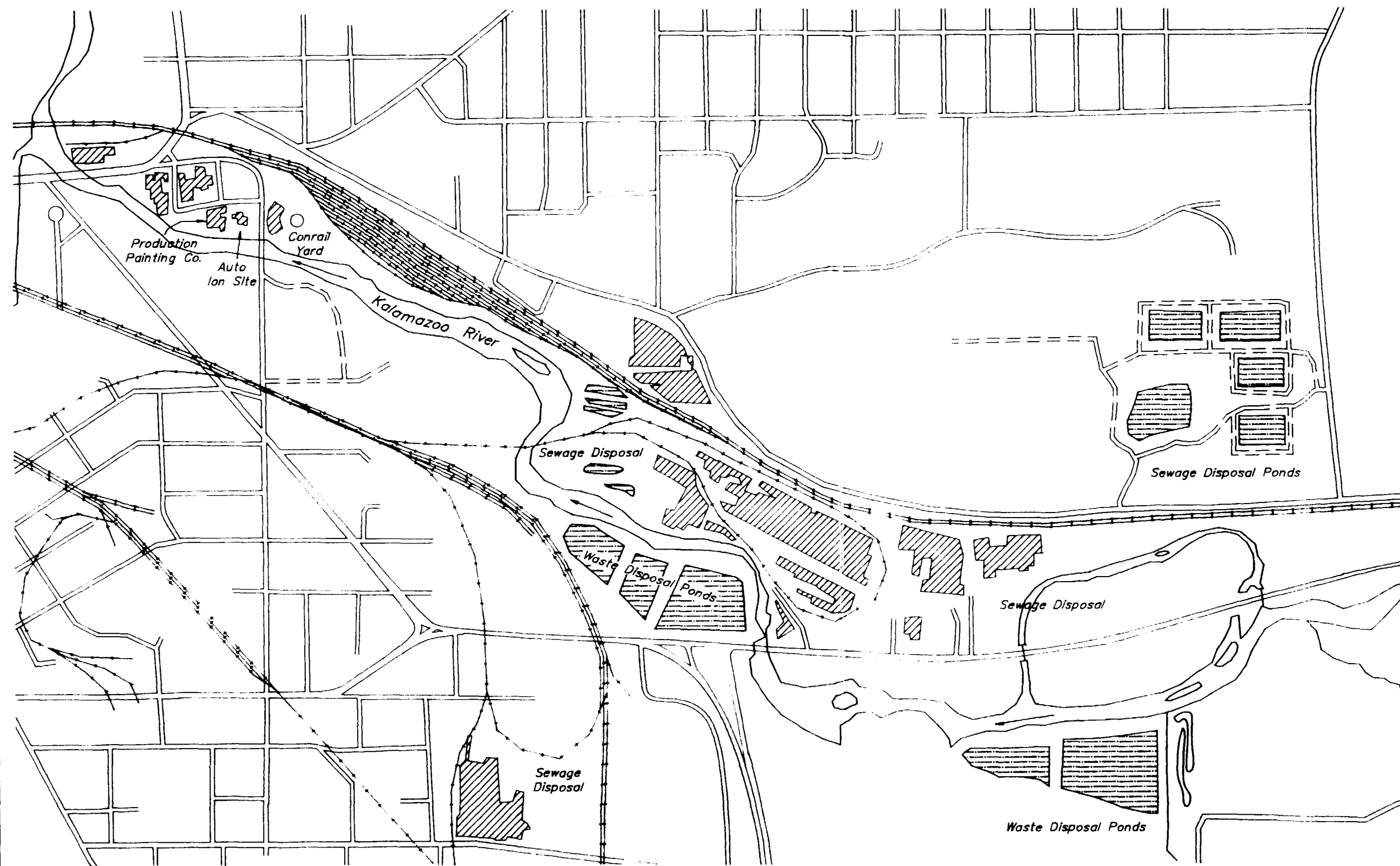
Both the City of Kalamazoo's and county's well site selection criteria provide a review process that is mandatory prior to any water well installation. This review process considers potential groundwater impact, past and present, locations and other available sources (municipal



U.S. Geological Survey
Kalamazoo Quadrangle
Michigan

SITE LOCATION MAP

AUTO ION SITE
KALAMAZOO, MICHIGAN



LEGEND

Industrial Building

Flow Direction

NOTE:
Taken From U.S. Geological Survey
Kalamazoo Quadrangle
Photorevised 1973

AUTO ION AREA MAP

AUTO ION SITE
KALAMAZOO, MICHIGAN

supply). The application for installation would require approval by city and county officials prior to installation.

Three known sites of environmental concern are located adjacent to the Auto Ion site. The Kalamazoo River is currently listed on the National Priorities List (NPL) and as an Act 307 (Michigan Public Act 307) site. This listing covers the lower portion of the river, beginning with a location approximately one mile upstream of the Auto Ion site and continuing 80 miles downstream to Lake Michigan. The primary concern is river sediment contamination from previous surface water discharges, especially polychlorinated biphenols (PCBs). There is a ban on consuming fish taken from this 80-mile stretch of the river.

The Conrail railroad yard is currently listed as an Act 307 site. Michigan Department of Natural Resources (MDNR) file information suggests that multiple spills have occurred at this site, including derailments and fueling spills¹ (see Appendix A). There are numerous accounts of oil seeping into the Kalamazoo River from groundwater at this site since at least 1973¹. Apparently, floating product has been present on the groundwater at this site since at least 1974; in December 1974, it was reported that 54,000 gallons of product had been recovered from the groundwater¹. As of December 1977, 122,250 gallons of product had been recovered¹. It appears that product recovery from the groundwater continues to be on-going. In August 1988, it was reported that 45,700 gallons had been recovered¹. In January 1989, it was reported that four feet of product was present in one on-site well¹. No groundwater analytical data, other than oil and grease, is available in MDNR files, USEPA files or the Steering Committee files. Several monitoring wells are located on Conrail's property boundary directly across the street from the Auto Ion site. Given the nature of operations at a large railyard which serviced and repaired locomotives, it is reasonable to suspect that metals, VOCs and petroleum contaminants may be present in site soils and/or groundwater² (see Appendix A). Groundwater flow moving west on the Auto Ion site has also been documented

¹Conrail Botsford Yard Site File, MDNR Plainwell Office

²McLeod, M.D., 1990, Environmental Investigations Counter Threat of Liabilities, Progressive Railroading, October, pp. 44-46.

(11/3/87). Although MDNR files document groundwater contamination at this site, it has not been established, with certainty, whether any contamination may be migrating from the railroad yard to the Auto Ion site¹.

The Production Painting Company, located immediately west of the Auto Ion site, is currently listed as an Act 307 site. The former owner of the Auto Ion facility reportedly made several complaints to regulatory agencies concerning the direct discharge of solvents from the adjacent painting facility onto the Auto Ion property³ (see Appendix B). An environmental assessment report prepared in August 1989 for Production Painting Company identified on-site contamination⁴ (see Appendix B). Soils within two feet of the surface contained VOCs and elevated concentrations of metals⁴. VOCs and elevated metals identified at this site include vinyl chloride, toluene, xylene, dichloroethane, cis-1,2-dichloroethene, 1,1,1 trichloroethane, ethyl benzene, trichloroethene, tetrachloroethene, barium, cadmium, chromium, lead and arsenic⁴. Groundwater also contained several VOCs and the flow direction at the time of the sampling was towards the Auto Ion site⁴. This investigation was very limited in nature. The actual extent of contamination at, and downgradient of, this site is unknown. The author of the Production Painting Environmental Assessment Report suggests that the source of the contamination at this facility is the Auto Ion site; however, there is insufficient data to make this conclusion. Although soil and groundwater contamination has been documented at this facility, it has not been established, with certainty, whether any contamination may be migrating from this facility onto the Auto Ion site.

Numerous industrial facilities are located upstream of the Auto Ion site which have discharged a wide variety of pollutants into the Kalamazoo River (see Remedial Investigation Section 3.7.3.3). National Pollution Discharge Elimination System (NPDES) permits document the discharge of various hazardous substances including volatile organics, semi-volatile organics and metals. In addition to direct discharges into the river, the land use upstream of the river is heavily

³Deposition of James Rooney taken September 27, 1989 by USEPA; pp. 91-93; Auto Ion Memo July 30, 1972.

⁴Groundwater and Soil Assessment for Production Painting Company, Maecorp Inc., August 1989.

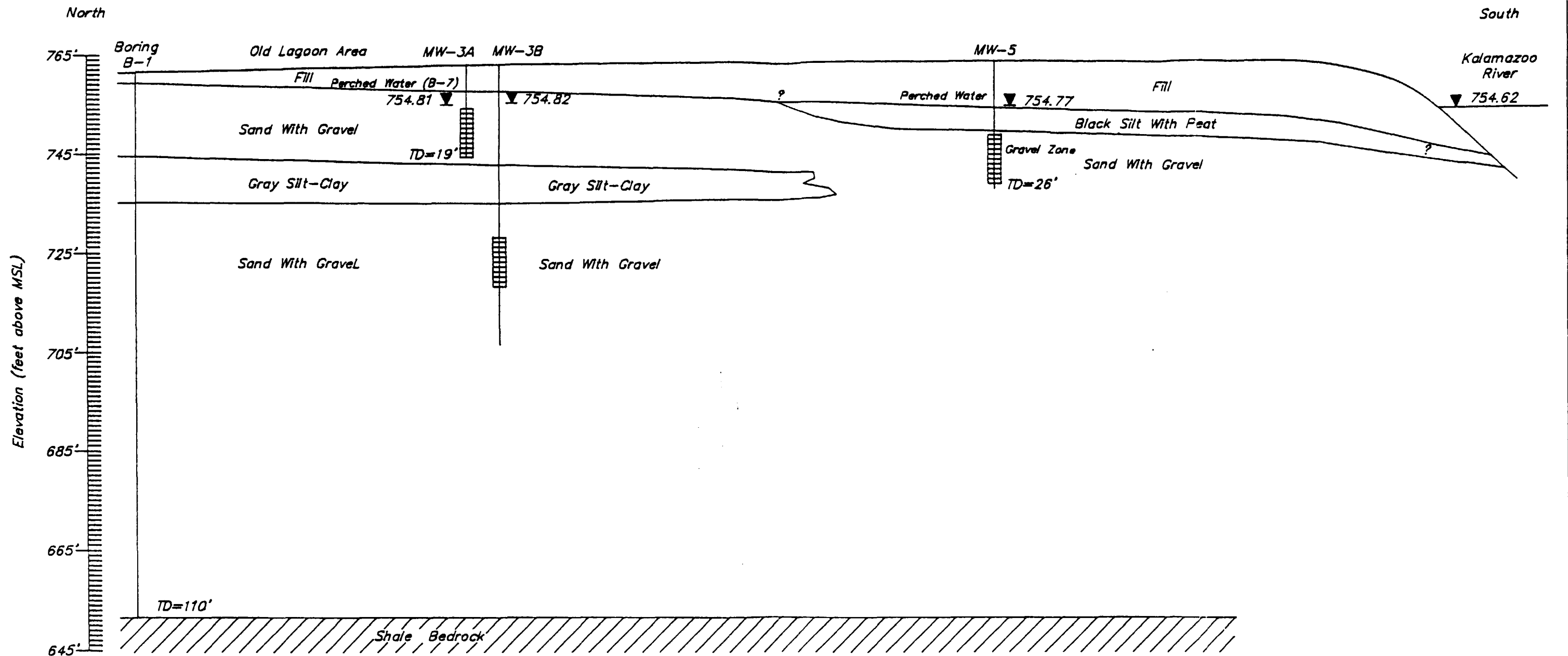
industrialized and may have resulted in significant amounts of hazardous substances being discharged into the river from non-point sources (see Figure 1-2).

The Auto Ion site and other properties along the river have filled in low lying areas adjacent to the river to increase development. Borings at the Auto Ion site have identified this underlying fill material as construction and demolition (C and D) type waste (e.g. concrete). A cross section of the extent of C and D fill underlying the Auto ion site is shown in Figure 1-3. According to the City of Kalamazoo, the golf course property directly across the river from the Auto Ion site was used as a municipal landfill. It is possible that fill materials along the Kalamazoo River upstream of the site may contain a variety of other types of waste materials which may have adversely impacted the river. However, no documentation or studies of the characteristics of any fill material upstream of the Auto Ion site are known to exist.

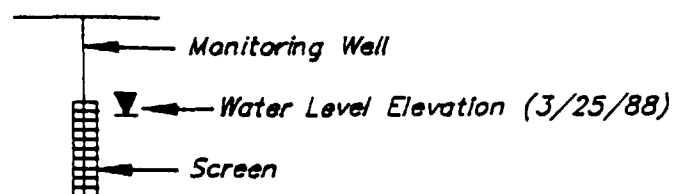
1.2.2 Site History

The Auto Ion site was used as an electrical generating station by the City of Kalamazoo from 1914 until 1956, when Consumers Power purchased the plant. The Auto-Ion Chemical Company (AICC) commenced operations at the site in 1964. The AICC was originally designed as a waste treatment facility for electroplating wastes. AICC received chromium and cyanide-bearing plating waste for treatment. Waste treatment operations included cyanide destruction and precipitation of heavy metals with the disposal of heavy metal sludges in an on-site lagoon. During these operations, poor waste handling practices reportedly resulted in multiple spills onto the surface soil at the site. AICC ceased active waste management operations in 1973. Both contained and uncontained wastes were left in the building and on the grounds at that time. The site was placed on the NPL in 1982.

FIGURE 1-3



LEGEND



Horizontal Scale 1" = 15'
Vertical Scale 1" = 20'

**NORTH-SOUTH CROSS SECTION
WESTERN PORTION OF SITE**

AUTO ION SITE
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1.2.3 Summary of Environmental Response Activities

1.2.3.1 Surface Removal

In 1985, a surface removal was conducted by O.H. Materials Corporation on behalf of certain potentially responsible parties (PRPs). The surface removal involved the containment and off-site disposal of all hazardous materials left at the site. Subsequent to the removal action, the City of Kalamazoo had the building demolished and basement backfilled. The only structures remaining on the property were the cement slab building foundation and a security fence around the property perimeter.

1.2.3.2 Operable Unit I

The environmental investigation of the site has been separated into two parts, called Operable Units. Operable Unit I deals with the soils on-site above the water table. The Remedial Investigation (RI) for Operable Unit I was conducted during 1987-1988 and the Feasibility Study (FS) was conducted in 1989 by Fred C. Hart Associates on behalf of certain PRPs. The results of the RI/FS for Operable Unit I documents the presence of residual chemicals on-site and identified a source control remedial action for soils and subsoils in the vadose zone. The remedial alternative to be implemented for Operable Unit I at the site is selective vadose zone excavation, stabilization, and off-site land disposal. Under this alternative, soils located within site boundaries with residual chemical concentrations greater than background and posing a health risk greater than 1.0×10^{-6} or hazard index greater than 1.0 will be excavated for off-site disposal. It is anticipated that approximately several thousand cubic yards of impacted soil will require excavation and disposal. An off-site land disposal facility that is approved by the United States Environmental Protection Agency (USEPA) will be selected for disposal of the excavated soils.

Operable Unit I will remove the only remaining source of groundwater contamination from previous operations at the Auto Ion site. Since there will be no additional on-site source of contamination, the impacted groundwater is expected to decrease in concentration as the

groundwater leaves the site and is recharged from the upgradient aquifer. Through this natural flushing process, groundwater quality is expected to substantially improve over time once Operable Unit I is completed. This assumes that there are no continuing off-site sources of contamination which could continue to adversely impact the groundwater. The source removal remediation for Operable Unit I is currently being designed for implementation and is expected to be completed in mid 1993.

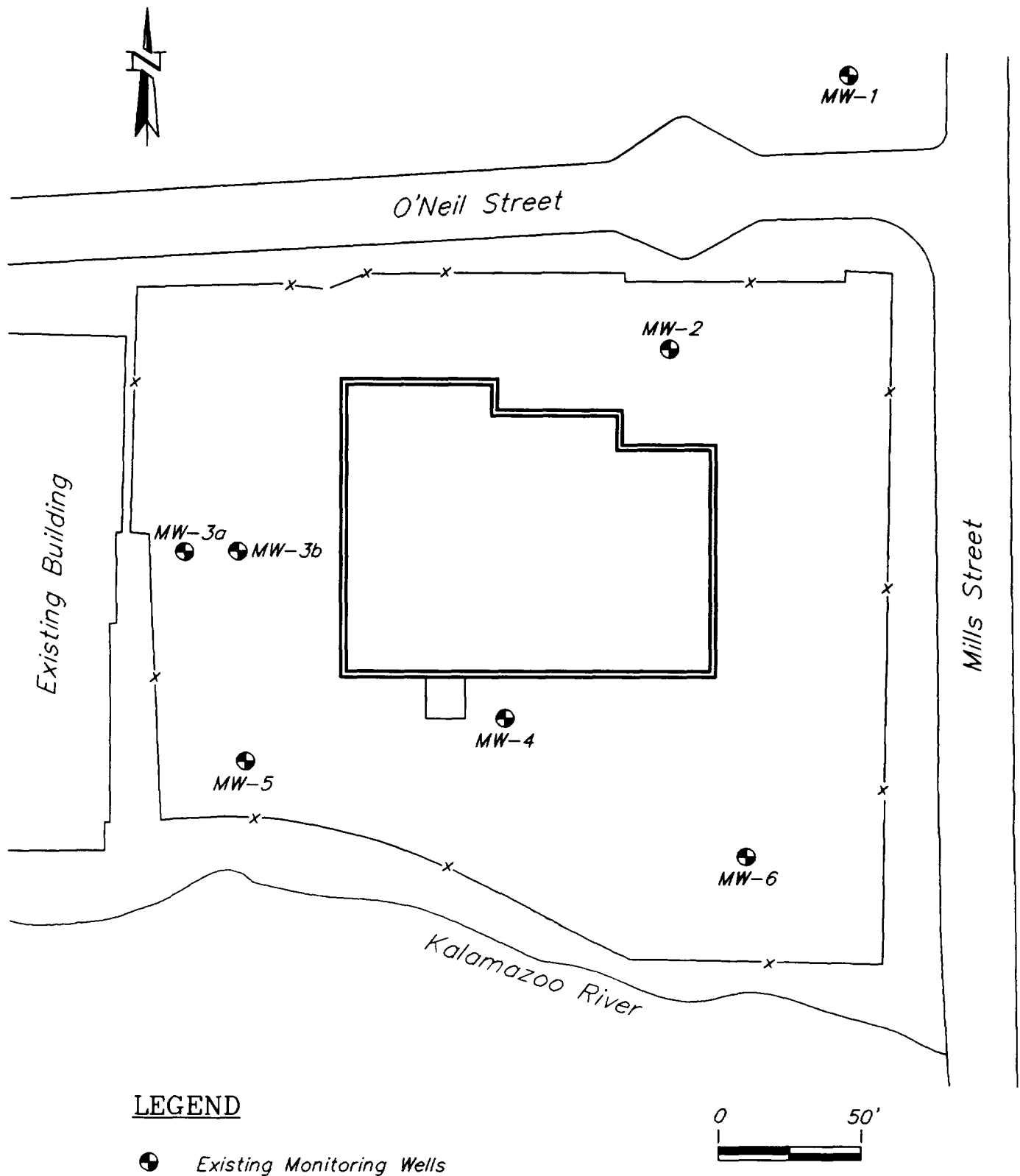
1.2.3.3 Operable Unit II

Operable Unit II is concerned with residual chemicals in the groundwater and is the subject of this FS. The RI for Operable Unit II was conducted and reported concurrently with the RI for Operable Unit I. As part of the RI, two rounds of groundwater samples were obtained. A third round of groundwater sampling was conducted in 1990, at the request of the USEPA, and this information was used to supplement the RI data base as an addendum report prepared by Eder Associates Consulting Engineers, P.C.

1.2.4 Extent of Impacted Groundwater

During the RI, seven monitoring wells were installed as shown on Figure 1-4. MW-1 is a shallow upgradient well, MW-3B is a deep well, and all other wells (MW-2, MW-3A, MW-4, MW-5 and MW-6) are shallow on-site wells.

The ten foot screens of the shallow wells were placed at depths which attempted to bridge the water table which is generally within ten feet of the surface. However, the screens for MW-4, MW-5 and MW-6 were set approximately between 12 and 22 feet deep, below a black clayey silt layer as shown on Figure 1-3. From the boring logs and groundwater elevations, it appears that MW-4, MW-5 and MW-6 are semi-confined, being screened below the low permeability black layer with perched water above the black clayey silt layer. The deep well (MW-3B) screen was set at an approximate depth of between 35 and 45 feet.



MONITORING WELL LOCATIONS

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Groundwater samples have been collected and analyzed during three sampling events in November 1987, March 1988 and December 1990. The analytical results are presented in Tables 1-1 and 1-2.

1.2.4.1 Results of Analyses - Inorganics

In general, the highest concentrations were found in the November 1987 event and the lowest concentrations in the December 1990 event. This may in part be due to the following conditions: 1) the November 1987 samples were not filtered; 2) the December 1990 samples were collected during high groundwater and river conditions; and, 3) the inorganic concentrations at the site may be decreasing with time since the facility is no longer operating and generating source material to impact the groundwater.

For many of the analytes, the concentrations vary significantly between sampling rounds. For example, aluminum concentrations are quite high in MW-1, MW-3A and MW-5 for the November 1987 sampling event, but are virtually non-detectable in these wells during the other sampling events. This is probably due to the variable nature of groundwater flow adjacent to the river. However, it creates uncertainty regarding the actual concentrations of the analytes in groundwater at the site.

MW-2, MW-4 and MW-6 appear to contain the highest concentrations of analytes. The upgradient well, MW-1, also contained several analytes at concentrations higher than would be expected for natural background. In general, inorganic concentrations in groundwater appear to be higher in the central and eastern portion of the site.

The higher inorganic concentrations of several of the analytes on the central and eastern portion of the site appear to result in a distinct pattern. These analytes are aluminum, barium, beryllium, cadmium, cobalt, iron, lead, magnesium, manganese, sodium and vanadium. The mean concentration of these analytes, for the three sampling events, are illustrated on Drawing 1 (see Appendix C). In general, for these analytes the concentrations decrease with distance from Mills

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TABLE 1-1

RESULTS OF GROUNDWATER ANALYSES (µg/l)
INORGANIC ANALYTES

	MW-1			MW-2			MW-3A			MW-3B		
Date	(a) 11/87	3/88	12/90	(a) 11/87	3/88	12/90	(a) 11/87	(b) 3/88	12/90	(a) 11/87	3/88	(b) 12/90
Aluminum	<200	38,600	<200	74,600	71,700	<200	<200	5,320/7,130	<200	<200	<200	<200/<200
Antimony	R	<60	<60	R	<60	<60	R	<60/<60	<60	R	<60	<60/<60
Arsenic	<10	R	<10	31	11	<10	<10	19/21	<10	<10	R	<10/<10
Barium	<200	384	<200	4,340	4,520	<200	<200	<200/<200	<200	<200	<200	<200/<200
Beryllium	<5	<5	<5	111	<5	<5	<5	<5/<5	<5	<5	<5	<5/<5
Cadmium	<5	13	<5	39	23	<5	<5	<5/5.3	<5	<5	<5	<5/<5
Calcium	156,000	427,000	152,000	961,000	488,000	151,000	304,000	328,000/335,000	242,000	149,000	153,000	166,000/166,000
Chromium (total)	<10	277	<10	1,000	599	371	<10	748/902	20	<10	19	<10/<10
Chromium (Hex.)	<10	<10	<10	<10	130	220	<10	<10/<10	20	<10	<10	<10/<10
Cobalt	<50	71	<50	312	125	<50	<50	<50/<50	<50	<50	<50	<50/<50
Copper	<25	R	<25	473	R	<25	<25	492/606	<25	<25	<25	<25/<25
Cyanide	<10	<10	<10	62	<10	<10	129	110/130	12	13	<10	<10/<10
Iron	<100	220,000	<100	46,200	278,000	<100	348	36,300/40,000	12,400	<100	2,050	1,800/1,880
Lead	<5	200	<5	568	230	<5	<5	45/57	<5	<5	8	<5/<5
Magnesium	41,800	117,000	38,800	245,000	138,000	28,800	24,300	32,900/38,200	27,900	47,200	46,300	47,700/47,700
Manganese	16	5,370	115	1,380	38,200	248	1,270	1,520/1,760	1,170	255	234	243/245
Mercury	<0.2	0.30	<0.2	1.5	<0.2	<0.2	<0.2	1.0/1.3	3.4	<0.2	<0.2	<0.2/<0.2
Nickel	<40	225	<40	3,630	12,300	281	270	1,620/1,770	40	211	<40	<40/<40
Potassium	5,720	8,310	5,640	11,100	12,000	6,600	20,100	26,000/28,600	31,900	5,000	5,000	<5,000/<5,000
Selenium	R	R	<5	R	R	<5	R	R/R	<5	R	R	<5/<5
Silver	<10	<10	<10	11	<10	<10	<10	<10/<10	<10	<10	<10	<10/<10
Sodium	163,000	140,000	148,000	133,000	106,000	122,000	66,800	66,800/77,200	90,100	80,300	74,700	108,000/108,000
Thallium	<10	<10	<10	<10	<10	<10	<10	<10/<10	<10	<10	<10	<10/<10
Vanadium	<50	108	<50	<50	178	<50	<50	<50/<50	<50	<50	<50	<50/<50
Zinc	<20	521	<20	855	640	<20	27	1,110/1,280	<20	32	<20	<20/<20

R - Unusable Data

(a) - Unfiltered Samples

(b) - Duplicates

J - Detection Limit Estimated

TABLE 1-1 Continued...

	MW-4			MW-5			MW-6		
Date	(a,b) 11/87	3/88	12/90	(a) 11/87	3/88	12/90	(a) 11/87	3/88	12/90
Aluminum	<200/13,800	4,680	<200	<200	11,000	205	33,100	36,600	<200
Antimony	R/R	<60	<60	R	<60	<60	R	<60	<60
Arsenic	12/33	24	30	<10	44	10	47	27	<10
Barium	<200/<200	<200	<200	<200	<200	<200	720	746	<200
Beryllium	<5/<5	<5	<5	<5	<5	<5	6.5	<5	<5
Cadmium	7.8/6.7	16	<5	<5	11	<5	23	16	<5
Calcium	230,000/352,000	473,000	323,000	228,000	361,000	178,000	960,000	488,000	132,000
Chromium (total)	27/R	222	10J	<10	1,370	10J	1,310	867	<10
Chromium (Hex.)	<10/<10	<10	10J	<10	<10	10J	<10	<10	<10
Cobalt	<50/<50	<50	<50	<50	<50	<50	76	53	<50
Copper	R/R	<25	<25	<25	1,150	<25	644	R	<25
Cyanide	2,700/2,850	50	33	40	40	21	11	<10	<10
Iron	R/R	16,800	12,300	<100	51,900	6,780	114,000	260,000	1,060
Lead	R/R	57	<5	<5	61	<5	388	240	<5
Magnesium	64,400/89,600	138,000	139,000	37,800	58,500	41,800	209,000	130,000	34,900
Manganese	R/R	1,690	743	1,390	1,980	568	11,200	5,120	674
Mercury	<0.2/<0.2	<0.2	<0.2	<0.2	2.7	<0.2	0.9	0.3	<0.2
Nickel	4,810/5,650	11,600	2,440	2,210	2,450	881	1,350	601	39
Potassium	114,000/118,000	92,600	104,000	41,200	28,300	22,500	13,400	13,100	7,040
Selenium	R/R	R	R	R	R	<5	R	R	<5
Silver	<10/<10	<10	<10	<10	<10	<10	<10	<10	<10
Sodium	543,000/551,000	298,000	320,000	132,000	120,000	103,000	196,000	153,000	103,000
Thallium	<10/<10	<10	<10	<10	<10	<10	<10	<10	<10
Vanadium	<50/<50	<50	<50	<50	<50	<50	65	120	<50
Zinc	R/R	4,910	103	214	1,090	57	782	537	<20

R - Unusable Data

(a) - Unfiltered Samples

(b) - Duplicates

J - Detection Limit Estimated

AUTO ION SITE
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TABLE 1-2

RESULTS OF GROUNDWATER ANALYSES ($\mu\text{g/l}$)
ORGANIC COMPOUNDS

	MW-1			MW-2			MW-3A			MW-3B		
Date	11/87	3/88	12/90	11/87	3/88	12/90	11/87	3/88	12/90	11/87	3/88	12/90
Chloromethane	<10	<10	<10	<10	<10	<10	<10	<10/<10	<10	<10	<10/<10	<10/<10
Vinyl Chloride	<10	<10	<10	<10	<10	<10	<10	<10/<10	<10	<10	<10/<10	<10/<10
Methylene Chloride	<5	<5	<5	<5	<5	<5	11	<5/<5	<5	<5	R	<5/<5
Trans-1,2-Dichloroethene	<5	<5	<5	<5	<5	<5	86	150/91	<5	<5	<5	<5/<5
1,2-Dichloroethene (total)	<5	<5	<5	<5	<5	<5	<5	<5/<5	31	<5	<5	<5/<5
1,2-Dichloroethane	<5	<5	<5	<5	<5	<5	<5	<5/<5	<5	<5	<5	<5/<5
Chloroform	<5	<5	<5	6	31	6	<5	<5/<5	<5	<5	<5	<5/<5
Trichloroethene	<5	<5	<5	5	<5	<5	92	100/62	<5	<5	<5	<5/<5
Tetrachloroethene	7	6	9	<5	<5	<5	<5	<5/<5	<5	<5	<5	<5/<5
1,2-Dichlorobenzene	<10	<10	<10	<10	<10	<10	<10	<10/<10	<10	<10	<10	<10J/<10J
2,4-Dimethylphenol	<10	<10	<10	<10	<10	<10	<10	<10/<10	<10	<10	<10	<10J/<10J
2,4,6-Trichlorophenol	<10	<10	<10	<10	<10	<10	22	<10/<10	<10	<10	<10	<10J/<10J
Diethylphthalate	<10	<10	<10	<10	22*	<10	<10	<10/<10	<10	<10	<10	<10J/<10J
Di-n-butylphthalate	150 B	<10	<10	100 B	<10	<10	140 B	<10/<10	<10	120 B	<10	<10J/<10J
Bis(2-ethylhexyl)-phthalate	24 B	<10	<10	50 B	<10	<10	30 B	<10/<10	43 B	24 B	<10	<10J/<10J

B - Compound detected in blank

R - Unuseable data

* - No blank data for round 2

J - Estimated value

Note: All other USEPA Target Compound List (TCL) Volatile Organics and semi-volatile organics were non-detectable for all three sampling rounds. TCL Pesticides were also analyzed during the 11/87 sampling event and found to be non-detectable.

TABLE 1-2 Continued...

Date	MW-4			MW-5			MW-6		
	11/87	3/88	12/90	11/87	3/88	12/90	11/87	3/88	12/90
Chloromethane	<10/<10	<10	38 J	<10	<10	<10	<10	<10	12 J
Vinyl Chloride	35/40	<10	48 J	24	<10	<10	<10	<10	<10 J
Methylene Chloride	560/550	R	<5	6	R	<5	<5	<5	<5 J
Trans-1,2-Dichloroethene	170/180	16	<5	<5	<5	<5	<5	<5	<5 J
1,2-Dichloroethene (total)	<5/<5	<5	180	<5	<5	10	<5	<5	<5 J
1,2-Dichloroethane	45/45	<5	<5	<5	<5	<5	<5	<5	<5
Chloroform	95/90	19	<5	<5	<5	<5	<5	<5	<5 J
Trichloroethene	410/420	160	160	15	<5	<5	<5	<5	<5 J
Tetrachloroethene	<5/<5	<5	<5	<5	<5	<5	<5	<5	<5 J
1,2-Dichlorobenzene	20/28	26	19 J	<10	<10	<10 J	<10	<10	<10 J
2,4-Dimethylphenol	<10/<10	<10	<10 J	<10	<10	<10 J	<10	<10	<10 J
2,4,6-Trichlorophenol	<10/<10	<10	<10 J	<10	<10	<10 J	<10	<10	<10 J
Diethylphthalate	<10/<10	<10	<10 J	<10	<10	<10 J	<10	<10	<10 J
Di-n-butylphthalate	100 B/74 B	<10	<10 J	<10	<10	<10 J	130 B	<10	<10 J
Bis(2-ethylhexyl)-phthalate	22 B/16 B	<10	<10 J	20 B	<10	<10 J	110 B	<10	<10 J

B - Compound detected in blank

R - Unuseable data

* - No blank data for round 2

J - Estimated value

Note: All other USEPA Target Compound List (TCL) volatile organics and semi-volatile organics were non-detectable for all three sampling rounds. TCL Pesticides were also analyzed during the 11/87 sampling event and found to be non-detectable.

Street, suggesting that their source is from the central and/or eastern portion of the site or from an off-site source east of the site. Immediately across Mills Street to the east is the Conrail Yard Roundhouse facility. The roundhouse facility was used to service and repair locomotives. As previously stated, monitoring wells are present along Conrail's property across from Auto Ion; however, no groundwater sampling data is available. Many of these analytes, other than aluminum, cadmium, iron, lead and sodium would not be expected to be constituents of the electroplating wastes previously handled at Auto Ion. The combination and concentrations of residual analytes shown on Drawing 1 appear typical of a water demineralization/softening treatment operation. This type of operation has been commonly used for the treatment of water for use in industrial boilers and locomotives. The source of these residuals in the groundwater may be from previous power plant boiler operations at the Auto Ion site and/or from water treatment residues from the Conrail Yard. The distribution of these analytes along the central and eastern site boundary including the upgradient off-site well (MW-1) suggests that at least some of these constituents may be from an off-site source. It is possible that all of these constituents could be from previous power plant boiler operations on the eastern portion of the Auto Ion site.

Drawing 2 (see Appendix D) illustrates the concentration distribution of the other analytes. These analytes are arsenic, calcium, chromium, copper, cyanide, mercury, nickel, potassium and zinc. All of these analytes would be expected to be present from previous operations at the Auto Ion site. Arsenic is commonly associated with coal ash from previous power plant operations. Calcium and potassium cyanide are common salts used in electroplating. Chromium, copper, mercury, nickel and zinc are all metals commonly used in electroplating. The distribution of these constituents across the site does not appear to occur in a distinct pattern.

An evaluation of the soil data from the Operable Unit I field investigation can be used to explain the presence of the metals common to electroplating operations; however, the soil data does not identify a correlation which can explain the presence of other elevated analytes in the groundwater on the eastern portion of the site.

The deep well, MW-3B, did not contain elevated concentrations of analytes.

MW-4 contained the highest concentration of several analytes; cyanide, nickel, potassium, sodium and zinc. The monitoring well logs indicate that the sand pack above the screen for MW-4 was set in the black silt with peat layer shown in Figure 1-3. Groundwater conductivity levels in this well are substantially higher (184 to >200 micromho/cm) and pH levels are slightly lower (6.6 to 6.9) than in the other monitoring wells (76 to 106 micromho/cm and pH of 6.9 to 7.1). This layer appears to be very high in organic content and is believed to be the former river bed. Based on this data, it appears as though some inorganic analytes in the groundwater are desorbing from this layer and increasing the concentrations in MW-4 compared to other on-site wells. A portion of the sand pack above the screens for MW-5 and MW-6 also extends into this peat layer. However, the peat layer does not appear to be impacting the groundwater quality at these wells as much as at MW-4; this may be due to increased flushing of these wells, since they are located closer to the river. Portions of this layer probably adsorbed analytes previously, when groundwater concentrations were probably higher due to active facility operations. This peat layer is located immediately above the groundwater and was sampled as a possible source during the Pre-Design sampling for Operable Unit I. If portions of this layer are found to contain high levels of contaminants, they will be removed as part of the Operable Unit I Remedial Action. However, to the extent this layer may be deeper than ten feet below the surface, it will not be addressed as part of OUI.

It is also possible that the explanation for high concentrations of constituents in MW-4 is due to a higher level of contamination on this portion of the site.

Aluminum, calcium, iron, magnesium, potassium and sodium were generally found in the 10 to 1,000 mg/l, or parts per million (ppm), range.

Barium, total chromium, cobalt, copper, cyanide, lead, manganese, nickel and zinc were found at elevated levels in many of the wells, including the upgradient well for several of the analytes. These analytes were generally found in the 10 to 1,000 μ g/l, or parts per billion (ppb), range.

Arsenic, cadmium and mercury were generally found at slightly elevated levels in most of the monitoring wells. These analytes were generally found in the low ppb concentrations.

Beryllium, hexavalent chromium and vanadium were only found in a few of the samples. Beryllium was only detected in two samples, at 6.5 $\mu\text{g/l}$ in MW-6 and in MW-2 at 111 $\mu\text{g/l}$, both samples were from the November 1987 sampling event. The highest concentrations of hexavalent chromium were found in MW-2. Vanadium was only identified during the November 1987 sampling event in MW-6 and in the March 1988 sampling event in MW-1, MW-2 and MW-6 at approximately equivalent concentrations.

Antimony, selenium, silver and thallium were only detected below or slightly above their detection limits.

1.2.4.2 Results of Analyses - Organic Compounds

The analyses results for organic compounds of all three groundwater sampling events were similar. Organic compounds identified in the groundwater are primarily chlorinated VOCs. A few semi-volatile compounds have also occasionally been found. In general, the greatest variety of compounds and highest concentrations were found in the November 1987 event. The number and concentrations of compounds generally decreased in the March 1988 samples. In general, the number and concentrations of compounds continued to decrease in the December 1990 sampling event, except MW-4, MW-5 and MW-6, which increased in concentration slightly from the second sampling event. Two new compounds were identified in the December 1990 sampling event; chloromethane and total 1,2-dichloroethene. The total 1,2-dichloroethene is probably the same compound as the trans-1,2-dichloroethene previously identified in the groundwater.

Two phthalate compounds, di-n-butylphthalate and bis(2-ethylhexyl)-phthalate, were only detected when similar concentrations were detected in the field blank. Phthalates are common sampling and laboratory contaminants which originate from plastic materials contacting the samples and/or equipment. Diethylphthalate was also detected in very low concentrations in one sample

during the March 1988 sampling event; however, the results of the field blank are unknown. Because the phthalate compounds were found in low concentrations and in sample blanks, it is reasonable to assume that they are not characteristic of the site groundwater, but are contaminants from sampling or laboratory equipment used to collect and analyze the samples.

It appears that the organics in the groundwater are decreasing with time. Biodegradation appears to be one mechanism for this decrease based on the concentrations and types of compounds present. Trichloroethene concentrations have decreased between the sampling events. Biological breakdown products of trichloroethene have generally been present in the monitoring wells where trichloroethene has decreased. These suspected breakdown products include trans-1,2-dichloroethene, 1,2-dichloroethene (total), 1,2-dichloroethane, vinyl chloride and chloromethane. (J. Dragun, The Soil Chemistry of Hazardous Materials, HMCRI 1988, pp357-364). Other reasons why the organics appear to be decreasing with time include the following conditions: 1) the December 1990 samples were collected during high groundwater and river conditions; and, 2) the concentrations at the site may be decreasing with time since the facility is no longer operating and generating source material to impact the groundwater.

MW-4 contains the greatest variety and highest concentrations of organic compounds. Monitoring wells MW-3A and MW-5 contain the next greatest variety and concentrations of organic compounds. The variety of organic compounds and concentrations in groundwater are highest in the western portion of the site.

The deep well, MW-3B, did not contain detectable concentrations of organic compounds.

The mean concentrations of the organic compounds in each well for the three sampling events are illustrated on Drawing 3 (see Appendix E). Compounds whose means were at the detection limit concentration were omitted from this drawing due to their insignificance and the phthalates have been omitted since they are assumed to be sampling and/or laboratory contaminants, as previously discussed. MW-4 is the primary location of impacts from organic compounds on groundwater. As previously discussed, the sand pack above the well screen for MW-

4 was set in the black silt with peat layer and appears to be impacted by the peat layer. Groundwater conductivity levels in this well are substantially higher (184 to >200 micromho/cm) and pH levels are slightly lower (6.6 to 6.9) than in the other monitoring wells (76 to 106 micromho/cm and pH of 6.9 to 7.1). This layer appears to be very high in organic content and is believed to be the former river bed. Based on this data, it appears as though organic compounds in the groundwater are desorbing from this layer and increasing the concentrations in MW-4 compared to other on-site wells. Portions of this layer probably adsorbed organic compounds previously, when groundwater concentrations were probably higher due to active facility operations. This peat layer is located immediately above the groundwater and was sampled as a possible source during the Pre-Design sampling for Operable Unit I. If portions of this layer are found to contain high levels of contaminants, they will be removed as part of the Operable Unit I Remedial Action.

The highest concentrations of organics in groundwater at MW-4 may be due to higher levels of organic contamination on this portion of the site.

Other than MW-4, MW-3A and MW-5 contain the highest levels of organic compounds. The distribution of these constituents on the central and western portion of the site suggests that they may have originated from operations on the central and/or western portion of the site or from the adjacent Production Painting facility. The former owner of the Auto Ion facility reportedly made several complaints to regulatory agencies concerning the direct discharge of solvents from the adjacent painting facility onto the Auto Ion property (see Appendix B). Limited sampling has occurred on this property; however, the sampling conducted revealed elevated levels of several VOCs and groundwater movement towards the Auto Ion site (see Appendix B). The author of the Production Painting Environmental Assessment Report suggests that the source of the contamination at this facility is the Auto Ion site; however, there is insufficient data to make this conclusion. Table 1-3 identifies the highest levels of VOCs identified in soils above the groundwater at both the Production Painting facility and Auto Ion site. The initial groundwater sampling results from Operable Unit I Remedial Design field work, conducted in November 1991, identified the following VOCs in groundwater on the western portion of the site; methylene chloride, acetone, chloroform, methyl ethyl ketone (MEK), 1,1,1-trichloroethane, trichloroethene, toluene, ethyl benzene and xylenes. These compounds are commonly used in painting operations.

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TABLE 1-3

COMPARISON OF VOCs IDENTIFIED IN SOILS
ABOVE THE GROUNDWATER AT THE PRODUCTION
PAINTING AND AUTO ION SITE

		(1)	(1)
<u>Compound</u>	<u>Auto Ion (µg/L)</u>	<u>Production</u>	
		<u>Painting (µg/L)</u>	
Acetone	110	-	
Methylene Chroide	24	-	
1,1-Dichloroethane	-	22	
Cis-1,2-Dichloroethene	-	28	
1,1,1-Trichloroethane	6	16	
Trichloroethene	96	-	
Tetrachloroethene	12	(2)	
Toluene	65	5,900	
Ethyl Benzene	6	170	
M/P-Xylene	-	1,500	
O-Xylene	-	620	

Notes:

- (1) Highest Concentration Identified
- (2) Compound positively identified, but concentration not contained in report
- Not detected

Although soil and groundwater contamination has been documented at the Production Painting facility, it has not been established, with certainty, whether any contamination may be migrating from this facility onto the Auto Ion site.

Trichloroethene, 1,2-dichloroethene and trans-1,2-dichloroethene were generally found in the 10 to 1,000 $\mu\text{g/l}$, or parts per billion (ppb) range.

Methylene chloride, a common laboratory contaminant, was only found during the November 1987 sampling event in three wells. Concentrations ranged from 6 to 560 $\mu\text{g/l}$. It is possible that these results are not characteristic of the site, but are from laboratory contamination. 1,2-Dichloroethane was also only found in the November 1987 sampling event in one well.

Vinyl chloride and chloroform have been found in two wells each and have been identified in more than one sampling event in the low ppb range.

Tetrachloroethene has only been identified in the upgradient well, MW-1, in each sampling event in very low ppb concentrations. This compound appears to be from an upgradient source of contamination since it has not been detected in on-site monitoring wells.

Chloromethane has only been identified in the December 1990 sampling event in two wells at low ppb concentrations.

1,2-Dichlorobenzene, a semivolatile organic compound has only been identified in MW-4 in each sampling event.

2,4,6-Trichlorophenol was only detected once, in MW-3A during the November 1987 sampling event at 22 $\mu\text{g/l}$.

2,4-Dimethylphenol has only been detected once, in MW-4, during the December 1990 sampling event at an estimated concentration below its detection limit.

1.2.4.3 Background Concentrations

It is difficult to determine background concentrations at the Auto Ion site due to groundwater flow reversals and the presence of only one off-site well. Groundwater in the off-site well appears to have been adversely impacted from off-site source(s) and/or possibly from flow reversals from the Auto Ion site. Table 1-4 compares the groundwater data between MW-1 (off-site well) and MW-2 (on-site well across the street from MW-1) for each sampling event. In order to demonstrate that a constituent is probably present from background source(s), MW-2 concentrations should not exceed MW-1 concentrations for each sampling event. If MW-2 concentrations are higher, the concentrations in MW-1 could be from either off-site source(s) or from the site when groundwater reversed flow.

The finding of a constituent in MW-1 consistently equal to or higher than MW-2, is an indication that the constituent is probably a background constituent or from an off-site source(s). As shown on Table 1-4, sodium and tetrachloroethene (PCE) are the only two constituents for which this demonstration condition exists. PCE is not a naturally occurring compound and is likely present from an upgradient source. Sodium levels in MW-3B, the deep well which exhibited almost no impact, also contains similar levels of sodium which also indicates its presence as a background constituent. Sodium was found in every groundwater sample from every well during all three sampling events at a range of 67,000 to 547,000 $\mu\text{g/l}$. Although some of the sodium in the groundwater may be from on-site sources, it appears that at least part of the sodium may be a result of other regional off-site source(s). In northern urban areas road salt is a common source of elevated sodium levels in shallow groundwater.

Sodium concentrations in groundwater pumped into the City of Kalamazoo's drinking water supply system (5,000 to 30,000 $\mu\text{g/l}$) are much lower than the concentrations of sodium around the Auto Ion site (>67,000 to 547,000 $\mu\text{g/l}$). The city drinking water contains levels of sodium below the USEPA health-based criteria of 20,000 $\mu\text{g/l}$. The lowest background groundwater concentration of sodium around the Auto Ion site greatly exceeds this criteria.

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TABLE 1-4

COMPARISON OF GROUNDWATER
CONCENTRATIONS IN MW-1 AND MW-2 (µg/l)

	<u>11/87 Sampling Event</u>			<u>3/88 Sampling Event</u>			<u>12/90 Sampling Event</u>		
	MW-1	MW-2	Highest Conc.	MW-1	MW-2	Highest Conc.	MW-1	MW-2	Highest Conc.
Aluminum	-	74,600	On-site	38,600	71,700	On-site	-	-	-
Antimony	R	R	-	-	-	-	-	-	-
Arsenic	-	31	On-site	R	11	On-site	-	-	-
Barium	-	4,340	On-site	384	4,520	On-site	-	-	-
Beryllium	-	111	On-site	-	-	-	-	-	-
Cadmium	-	39	On-site	13	23	On-site	-	-	-
Calcium	156,000	961,000	On-site	427,000	488,000	On-site	152,000	151,000	Off-site
Total Cr	-	1,000	On-site	277	599	On-site	-	371	On-site
Hex Cr	-	-	-	-	130	On-site	-	220	On-site
Cobalt	-	312	On-site	71	125	On-site	-	-	-
Copper	-	473	On-site	R	R	-	-	-	-
Cyanide	-	62	On-site	-	-	-	-	-	-
Iron	-	46,200	On-site	220,000	278,000	On-site	-	-	-
Lead	-	568	On-site	200	230	On-site	-	-	-
Magnesium	41,800	245,000	On-site	117,000	138,000	On-site	38,800	28,800	Off-site
Manganese	16	1,380	On-site	5,370	38,200	On-site	115	248	On-site
Mercury	-	1.5	On-site	0.3	-	Off-site	-	-	-
Nickel	-	3,630	On-site	225	12,300	On-site	-	281	On-site
Potassium	5,720	11,100	On-site	8,310	12,000	On-site	5,640	6,600	On-site
Selenium	R	R	-	R	R	-	-	-	-
Silver	-	11	On-site	-	-	-	-	-	-
Sodium	163,000	133,000	Off-site	140,000	106,000	Off-site	148,000	122,000	Off-site
Thallium	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	108	178	On-site	-	-	-
Zinc	-	855	On-site	521	640	On-site	-	-	-
Tetrachloroethene	7	-	Off-site	6	-	Off-site	9	-	Off-site

Notes:

-: Not detected

R: Unuseable data

The United States Geological Survey (USGS) conducted a groundwater survey of Kalamazoo County in 1986-88 which is contained in its Water-Resources Investigations Report 90-4028. As part of the survey it developed median concentrations for several natural background groundwater constituents for the county, common background metals are listed below:

<u>Analyte</u>	<u>USGS Background ($\mu\text{g/l}$)</u>	<u>Auto Ion Concentration Range ($\mu\text{g/l}$)</u>
Calcium	81,000	132,000 to 961,000
Iron	540	< 100 to 278,000
Magnesium	25,000	24,300 to 245,000
Manganese	50	16 to 38,800
Potassium	1,000	< 5,000 to 116,000
Sodium	5,100	66,800 to 547,000

These concentrations are generally much lower than those identified at the Auto Ion site. Although higher concentrations might be expected in discharge zones of an aquifer, the levels would not be expected to be this high. The background sodium concentration in groundwater near the site does not meet USEPA health-based criteria for potable water. This condition is not unusual for shallow groundwater in highly industrial and/or urbanized areas.

1.2.4.4 Summary

Shallow groundwater (<35 feet deep) at the Auto Ion site contains elevated levels of several metals, VOCs and very minor amounts of a few semivolatile organics. The highest concentrations of metals are in the central and eastern portion of the site. High levels of sodium exceeding health-based drinking water criteria may be due to off-site source(s) and/or from the Auto Ion site. Metals of concern are generally in the ppb to low ppm range. The highest concentrations of VOCs are in the central and western portion of the site. VOCs are generally in the low ppb range. Some metals and VOCs may be from undefined off-site sources.

1.2.5 Contaminant Fate and Transport

Chemical fate and transport through and from the groundwater system at the Auto Ion site is primarily dependent on the individual properties of the residual chemicals present, the hydrogeological conditions and hydrological properties of the Kalamazoo River.

1.2.5.1 Chemical Properties

Elevated concentrations of several metals are present in the groundwater. Although metals are often considered relatively insoluble and immobile, in aqueous systems many inorganic elements exist in more than one molecular or ionic form which can be quite soluble. The various forms at which these metals can exist in the groundwater have different affinities for adsorption onto aquifer matrix materials and have different solubilities. Generally, metals are present in ionic forms with varying degrees of mobility in groundwater. As demonstrated by sampling results, many metals are dissolved and mobile within the aquifer. Some fraction of the metals present will adhere to the aquifer materials. However, over time when soluble metals move out of the aquifer, those metals which are adsorbed to aquifer materials will become more soluble to maintain the partitioning equilibrium.

A black silt with peat layer is shown on Figure 1-3. This layer appears to be the old river bed which probably contains high concentrations of organic material. This material has a much greater affinity for the adsorption of both inorganic and organic residual chemical constituents in the groundwater.

VOCs present in the groundwater are generally quite soluble. These compounds are not expected to adsorb to aquifer materials as strongly as inorganics. The VOCs at this site are chlorinated and can undergo various transformations including hydrolysis, oxidation/reduction and biodegradation.

1.2.5.2 Hydrogeological Conditions

Approximately 110 feet of sand with varying amounts of gravel predominate the unconsolidated deposits which overlie the shale bedrock at the site. The sand and gravel deposits

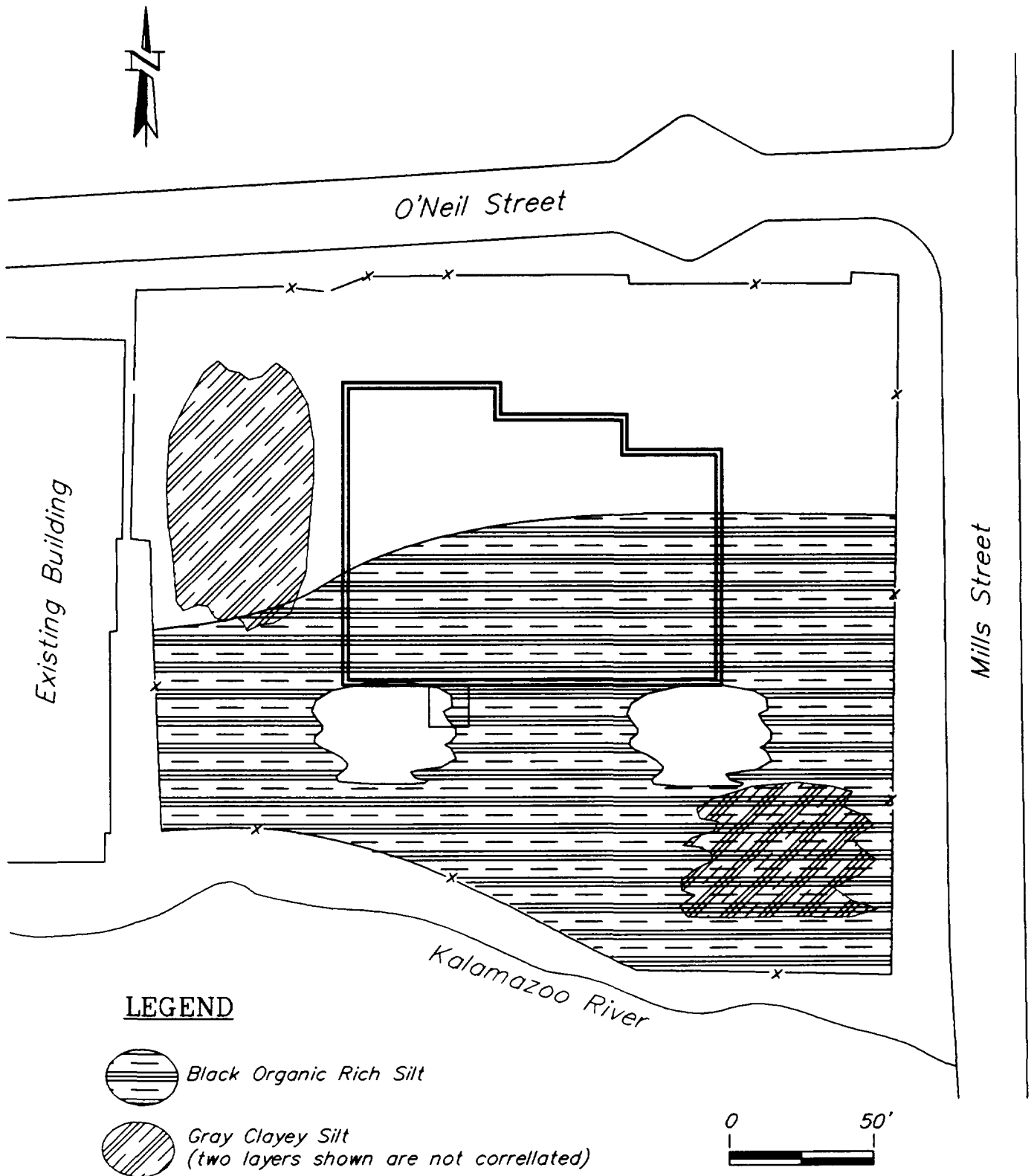
are very permeable to groundwater movement. Groundwater is generally within ten feet of the surface and normally flows towards the Kalamazoo River, where it eventually discharges into the river.

Boring and monitoring well logs revealed the presence of two layers of low permeability deposits which may potentially affect groundwater flow and are shown on Figures 1-3 and 1-5. The southern half of the site is characterized by a one to four foot thick layer of black organic deposits containing varying amounts of silt, clay and peat. This black layer is probably the old riverbed which has been filled in to form the present grade. Although perched water has been identified on top of this layer, the quantity has been reported as too small to sample by geologists installing borings through this layer.

A 5 to 7 foot thick layer of gray clay (dry) is present at about 16 to 18 feet below grade in the northwestern quarter of the site (Figure 1-5). A saturated gray silt layer was found in the center of the site (B-2) at the same elevation which may be the same layer with a change in lithology from clay to silt.

The effect of the black layer and gray clay (silt) on groundwater occurrence can be evaluated on the basis of water levels in monitoring wells screened above and below these layers. For example, monitoring wells MW-4, MW-5 and MW-6 are screened in sand and gravel below the black layer. Water levels in these wells were at, or above, the top of the black layer during high water level periods and just above the bottom of the black layer during low water level periods. Water levels of all monitoring wells at the site rise and fall with the river level. The relationship of the water level to the black layer for monitoring wells near the river (MW-4, MW-5 and MW-6) indicates aquifer confinement at these locations. Therefore, the water levels in these wells do not represent the top of the saturated zone which is at the sand and gravel-black layer interface at these locations.

Monitoring wells MW-3A and MW-3B are screened above and below a gray clay layer (16-23 feet below grade), respectively, that is present in the northwest corner of the site. The known on-site extent of the clays is shown on Figure 1-4. The gray clay lenses shown in the southwest

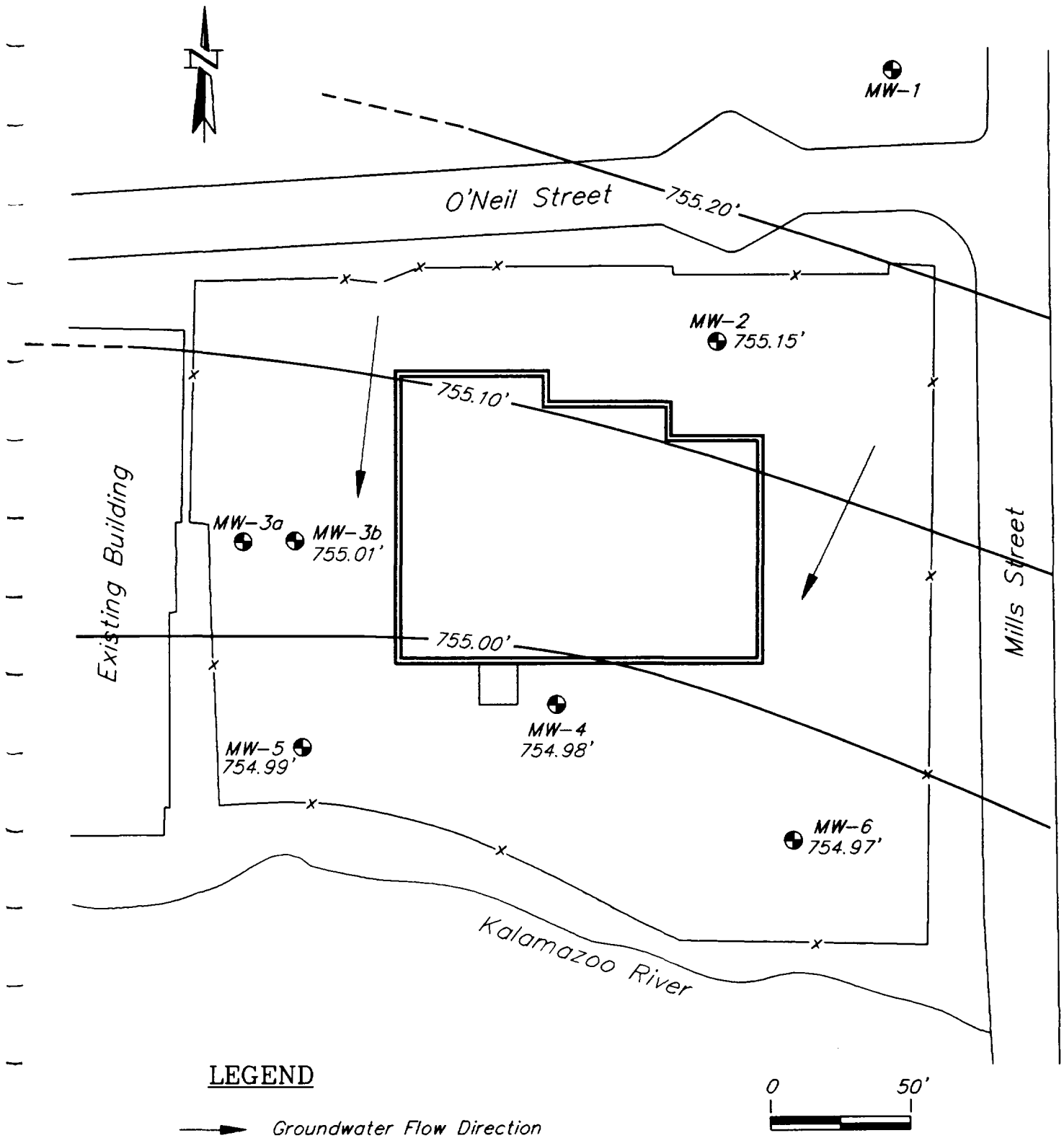


ESTIMATED AREAL EXTENT (ON-SITE) OF CLAY LAYERS

AUTO ION SITE
KALAMAZOO, MICHIGAN

corner occurs at 33 feet below grade and is only 16 inches thick. There is no black layer at MW-3A and its water level represents the top of the saturated zone. Water levels for MW-3A and MW-3B were almost the same on each of the water level measurement rounds of the RI. This indicates incomplete confinement of the lower zone and horizontal flow in both zones. Both zones apparently respond to changes in river level by the same magnitude. This condition should exist throughout the site where this gray clay zone is present. Based on this data, horizontal flow conditions should characterize the water bearing zone to a depth of at least 45 feet below grade. Theoretically, monitoring wells screened in the zone between 45 feet and bedrock (110 feet) would have higher water levels representing upward flow toward the discharge point in the river bottom. Overall, there appears to be no downward flow component for groundwater that would result in the downward migration of chemical residues found in the upper 20 feet, approximately, of the saturated zone. Typically, deeper groundwater near the river would have an upward flow component representing the discharge of groundwater to the river.

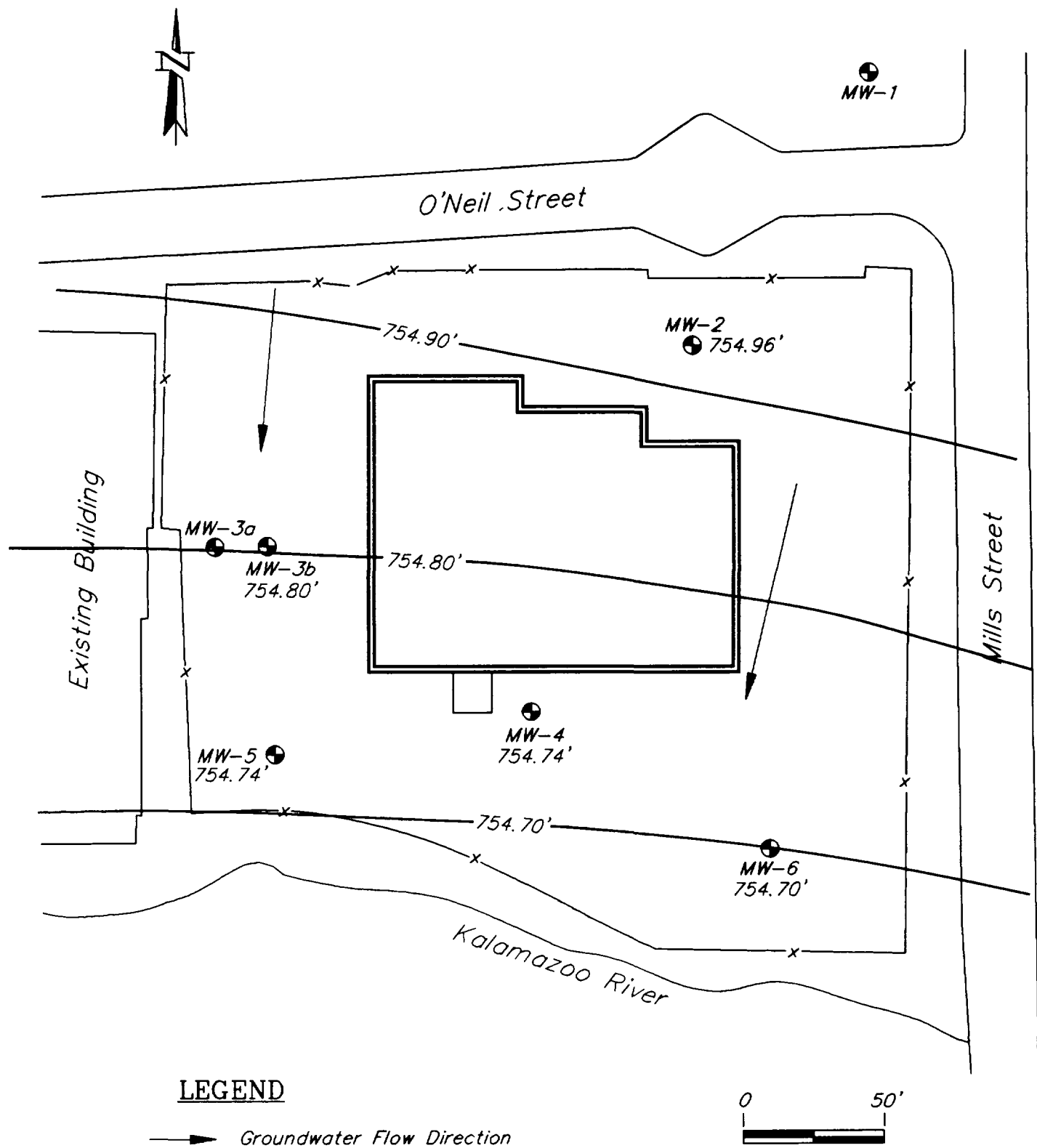
Water-table maps shown on Figures 1-6 through 1-17 indicate that apparent reversals of groundwater flow directions occur in response to river level fluctuations. This condition is common along the edges of rivers, but usually is a temporary seasonal condition that does not extend very far away from the river's edge. The change in water level is caused by both the seepage of river water into the bank and by a response of the saturated zone to the loading caused by the increased weight of the river during higher river stages. The latter cause and effect usually causes the initial rise while infiltration of river water into the groundwater reservoir lags behind. At this site, monitoring wells closest to the river are screened in a confined zone beneath the black layer and it is probable that, under confined conditions reflective of hydraulic pressures caused by confinement, these wells may exhibit greater water level fluctuations as the river rises. This exaggerated response to river level rises may result in apparent flow reversals indicated by water table maps based on water level elevations in monitoring wells screened in unconfined (MW-1, MW-2, and MW-3A) and confined zones (MW-4, MW-5, and MW-6). Therefore, these temporary apparent flow reversals make it difficult to interpret the extent of the impact of the river water quality on groundwater quality.

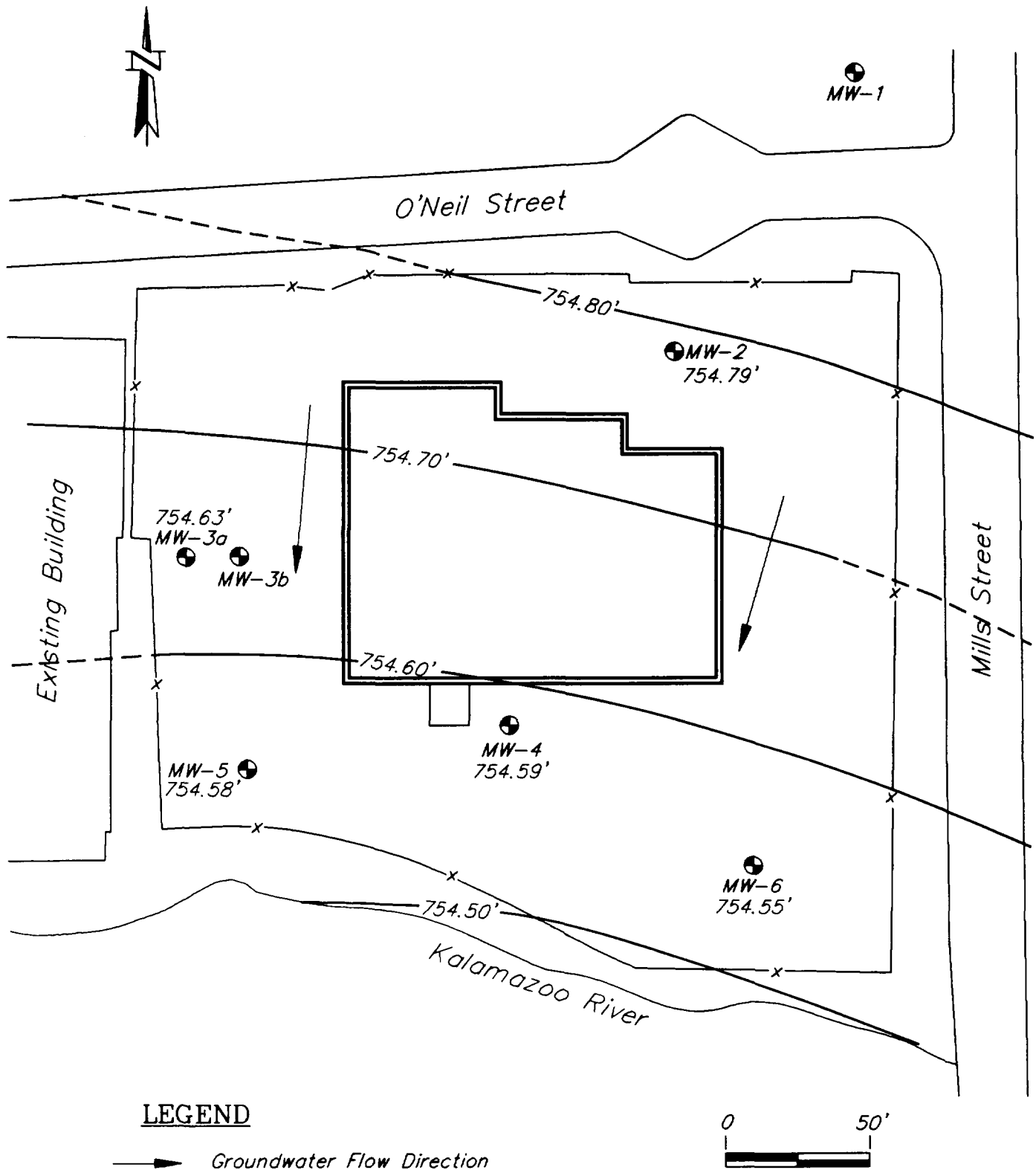


POTENTIOMETRIC SURFACE MAP NOVEMBER 21, 1991

AUTO ION SITE
 KALAMAZOO, MICHIGAN

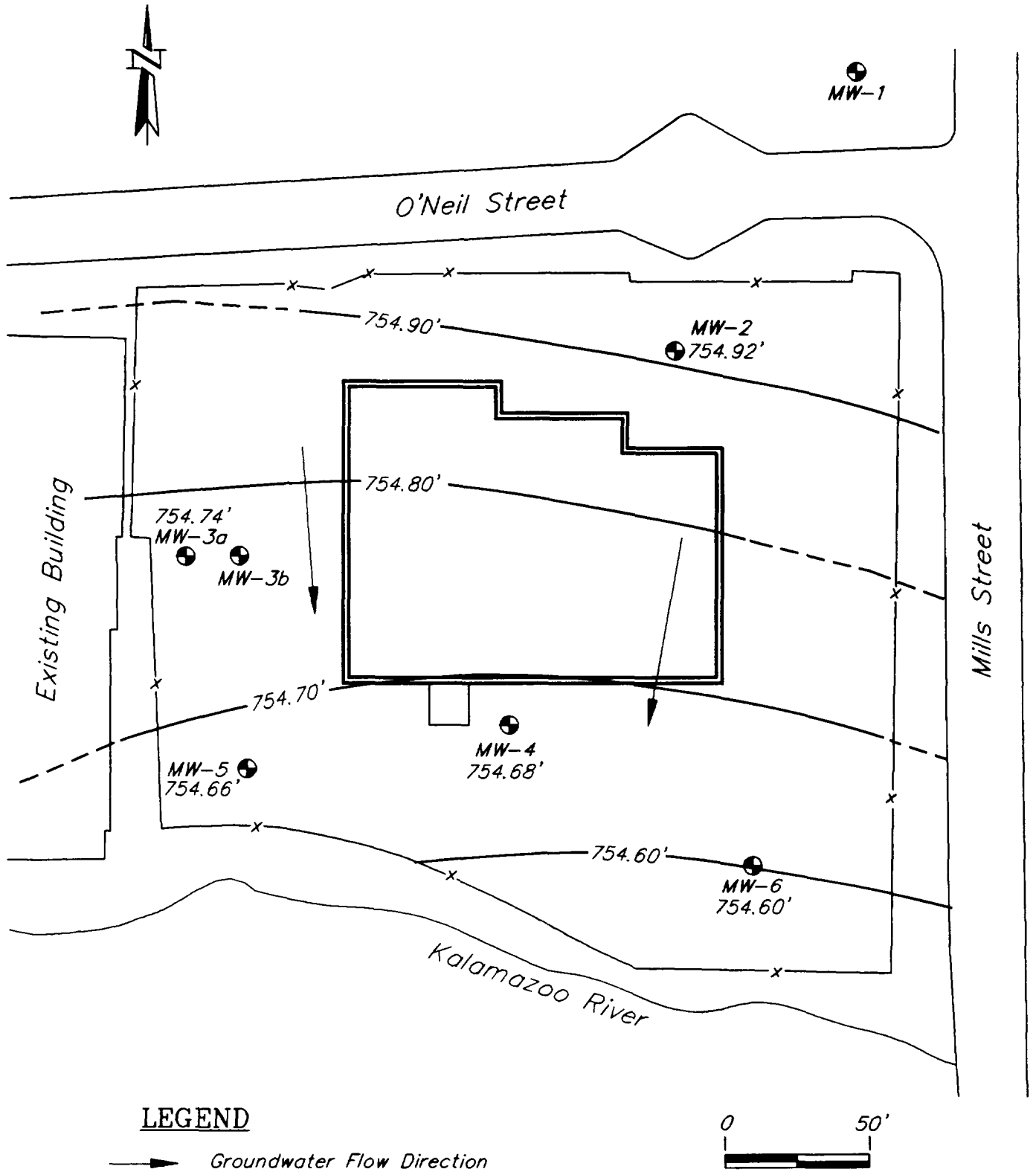
MS684030
 110293





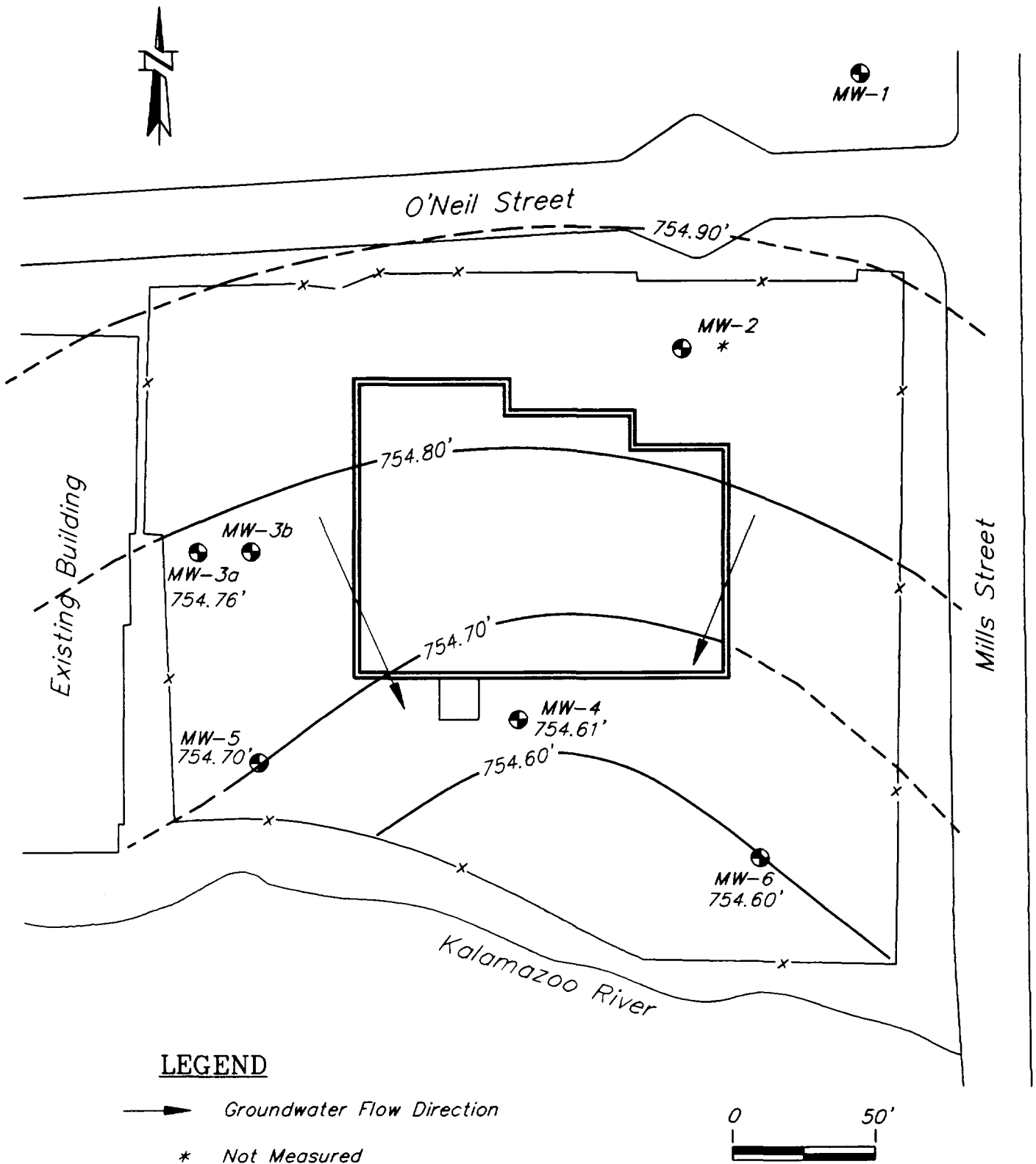
POTENTIOMETRIC SURFACE MAP NOVEMBER 13, 1991

AUTO ION SITE
 KALAMAZOO, MICHIGAN



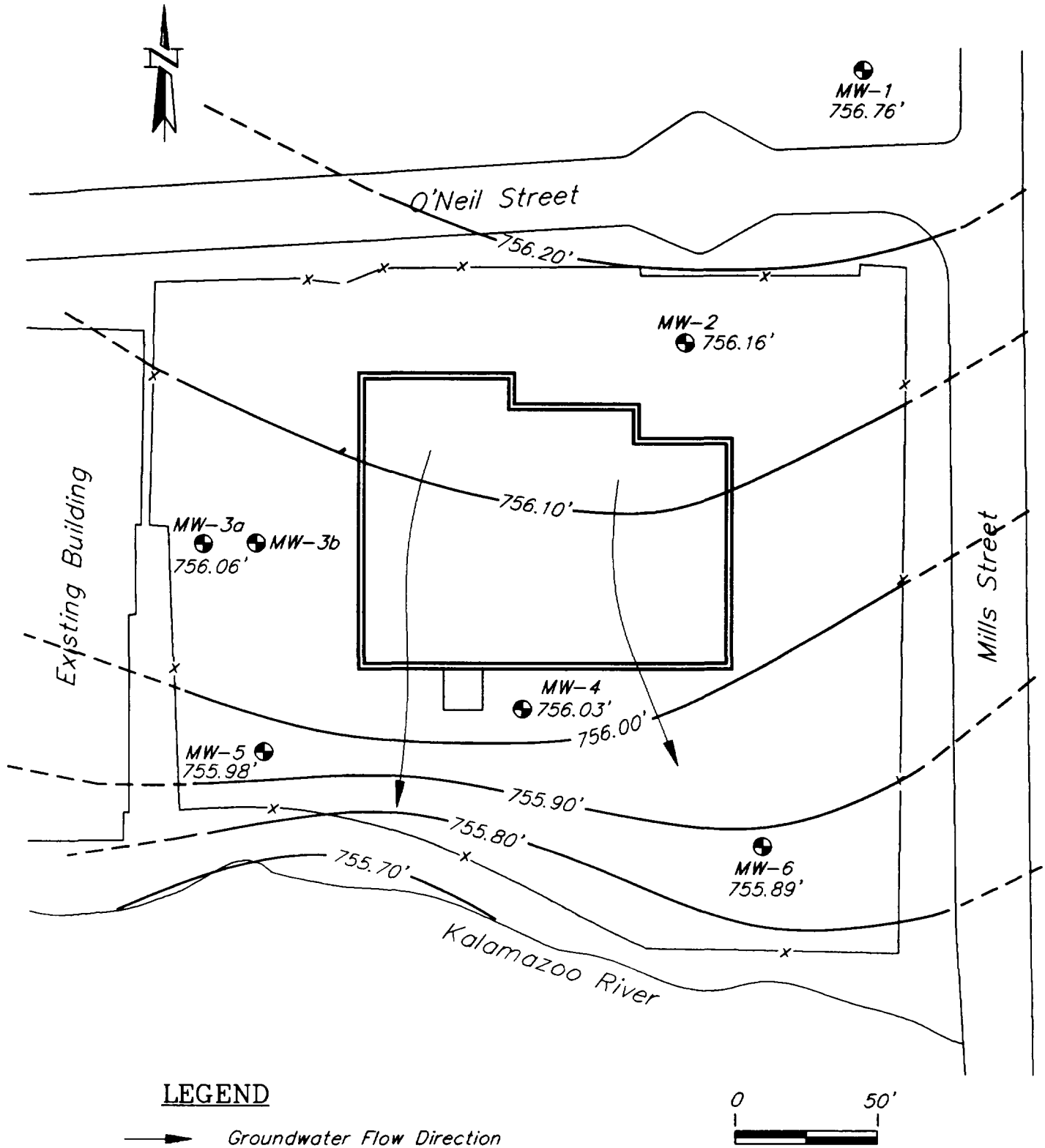
POTENTIOMETRIC SURFACE MAP NOVEMBER 12, 1991

AUTO ION SITE
KALAMAZOO, MICHIGAN



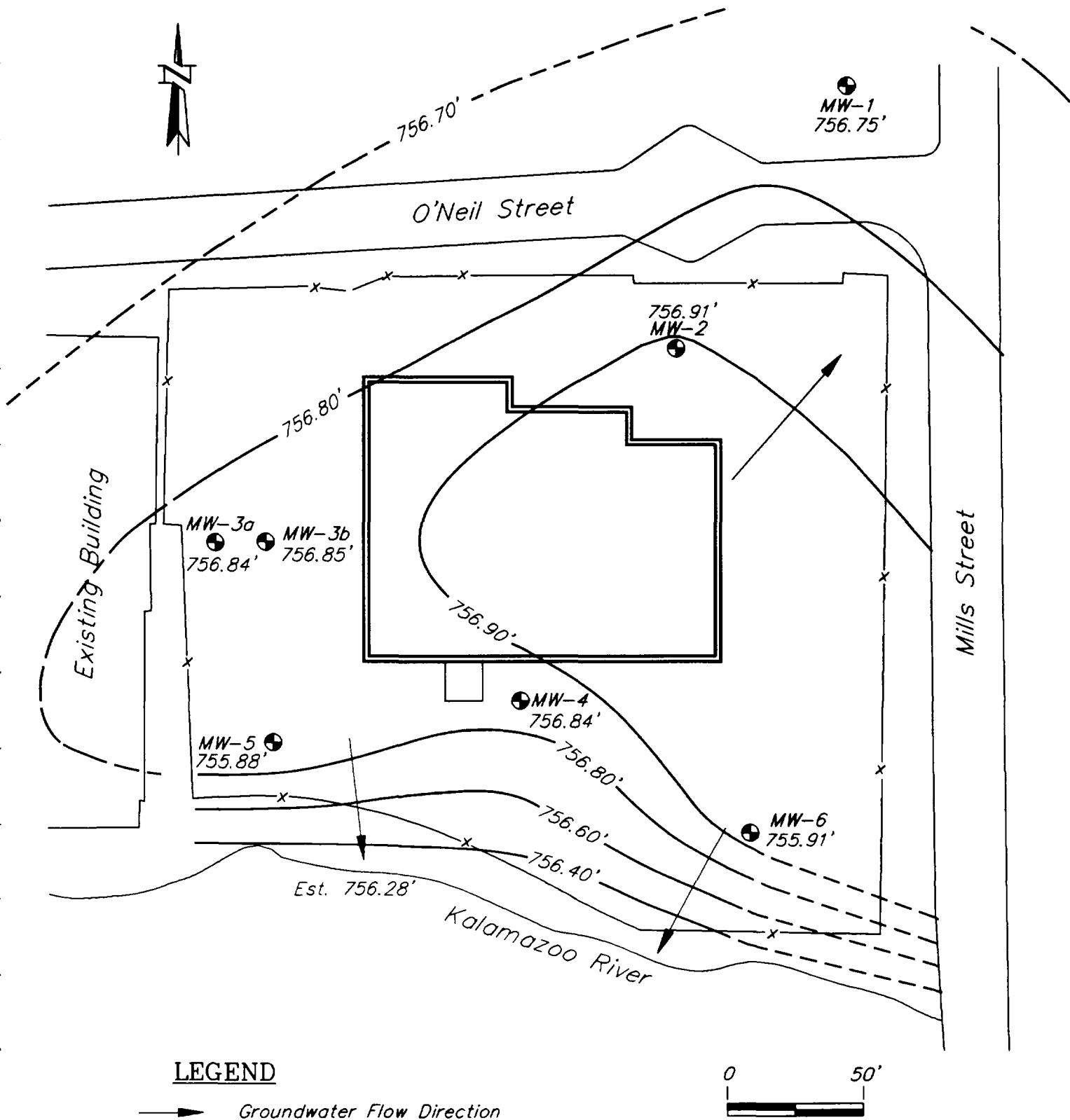
POTENTIOMETRIC SURFACE MAP NOVEMBER 11, 1991

AUTO ION SITE
 KALAMAZOO, MICHIGAN



POTENTIOMETRIC SURFACE MAP DECEMBER 10, 1990

AUTO ION SITE
 KALAMAZOO, MICHIGAN



POTENTIOMETRIC SURFACE MAP DECEMBER 6, 1990

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AUTO ION SITE
KALAMAZOO, MICHIGAN

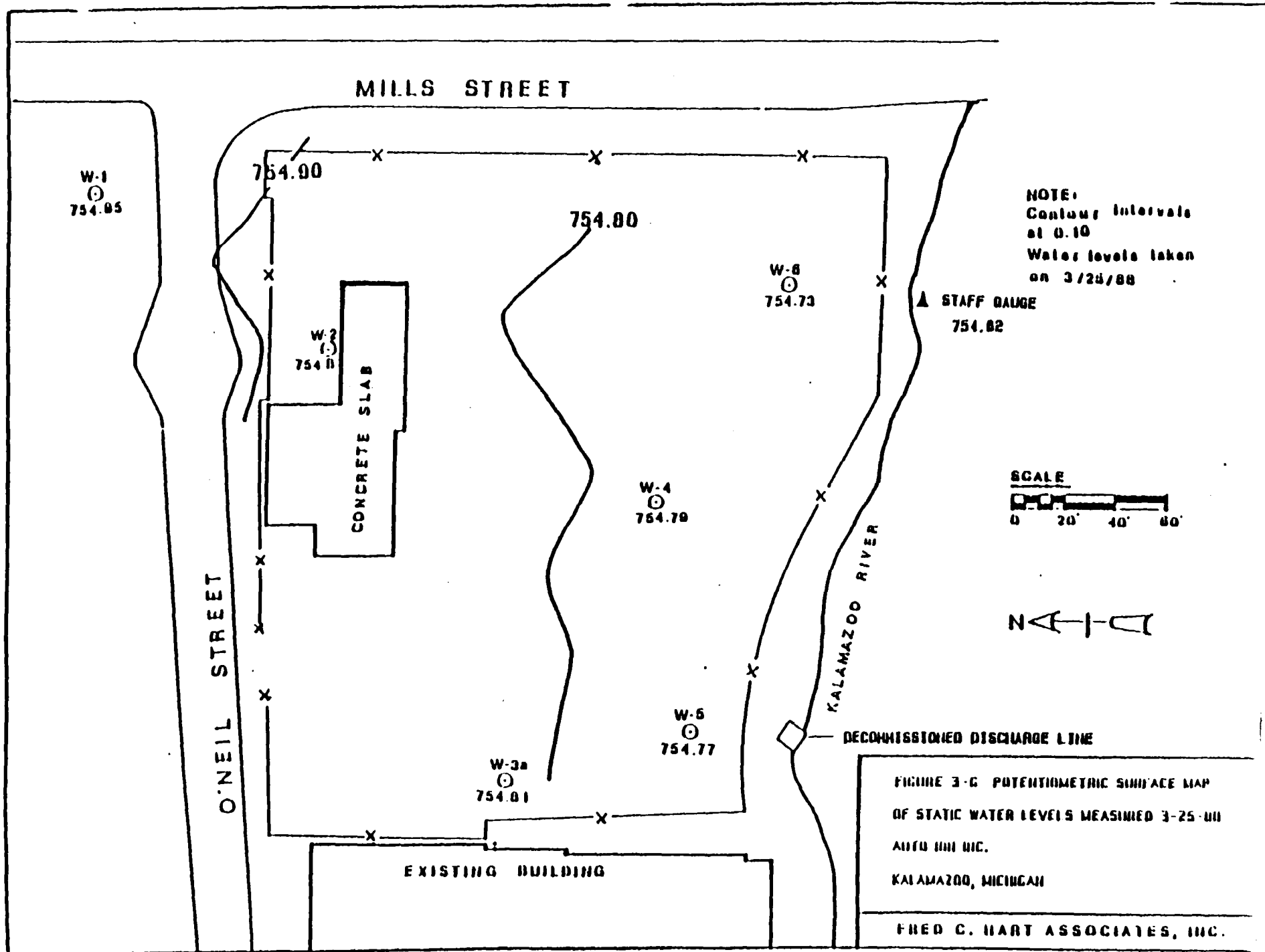


FIGURE 1-13

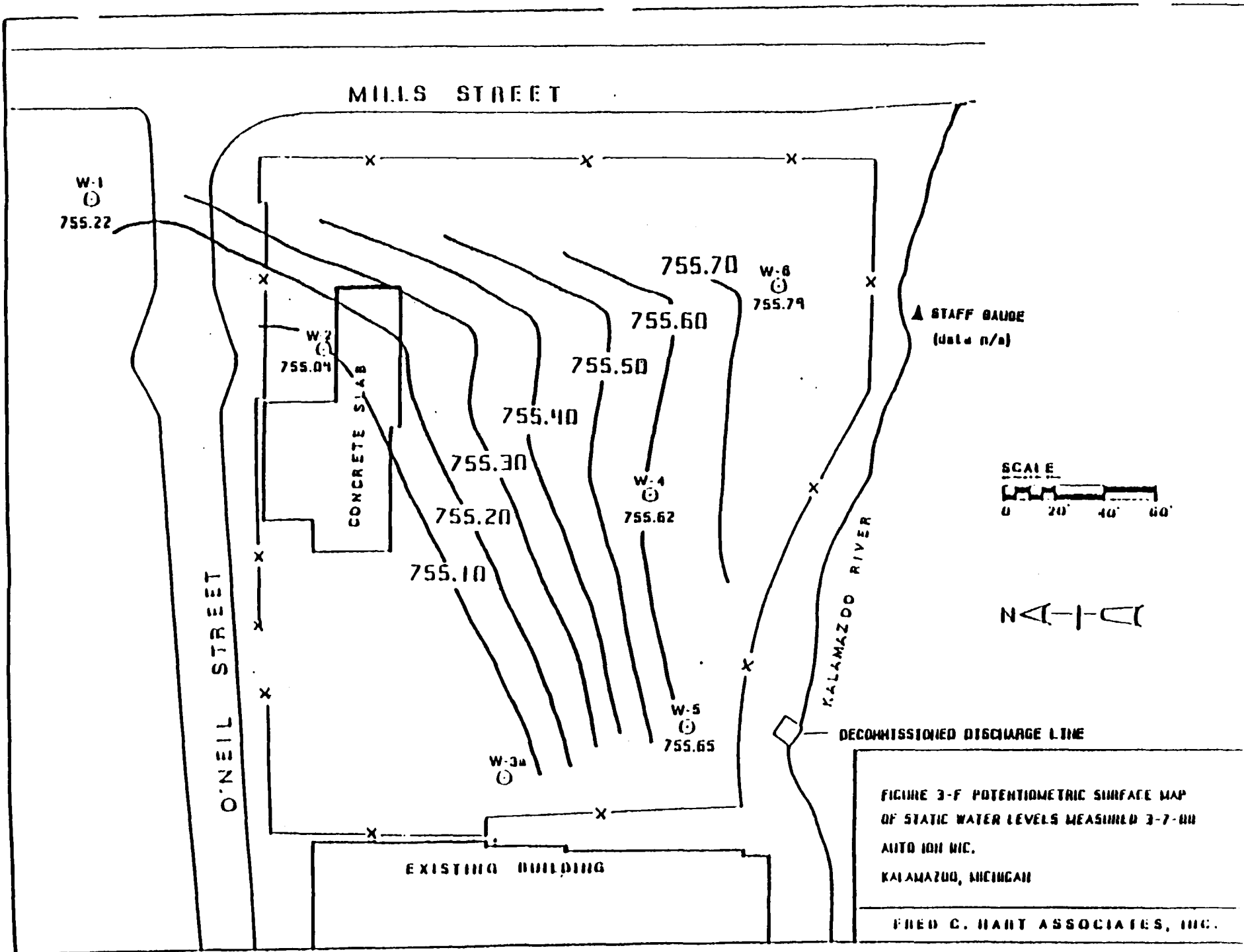


FIGURE 1-14

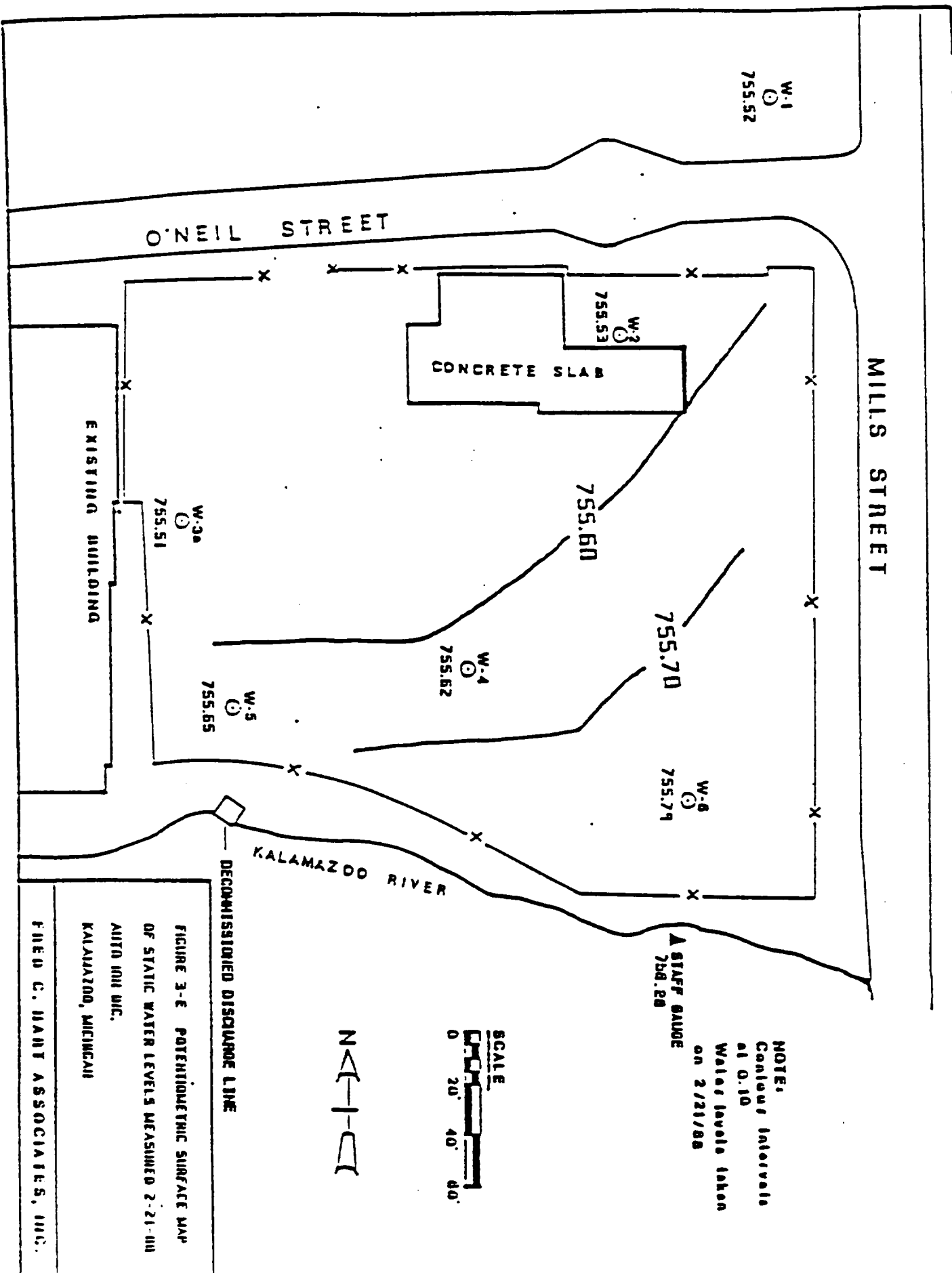


FIGURE 1-15

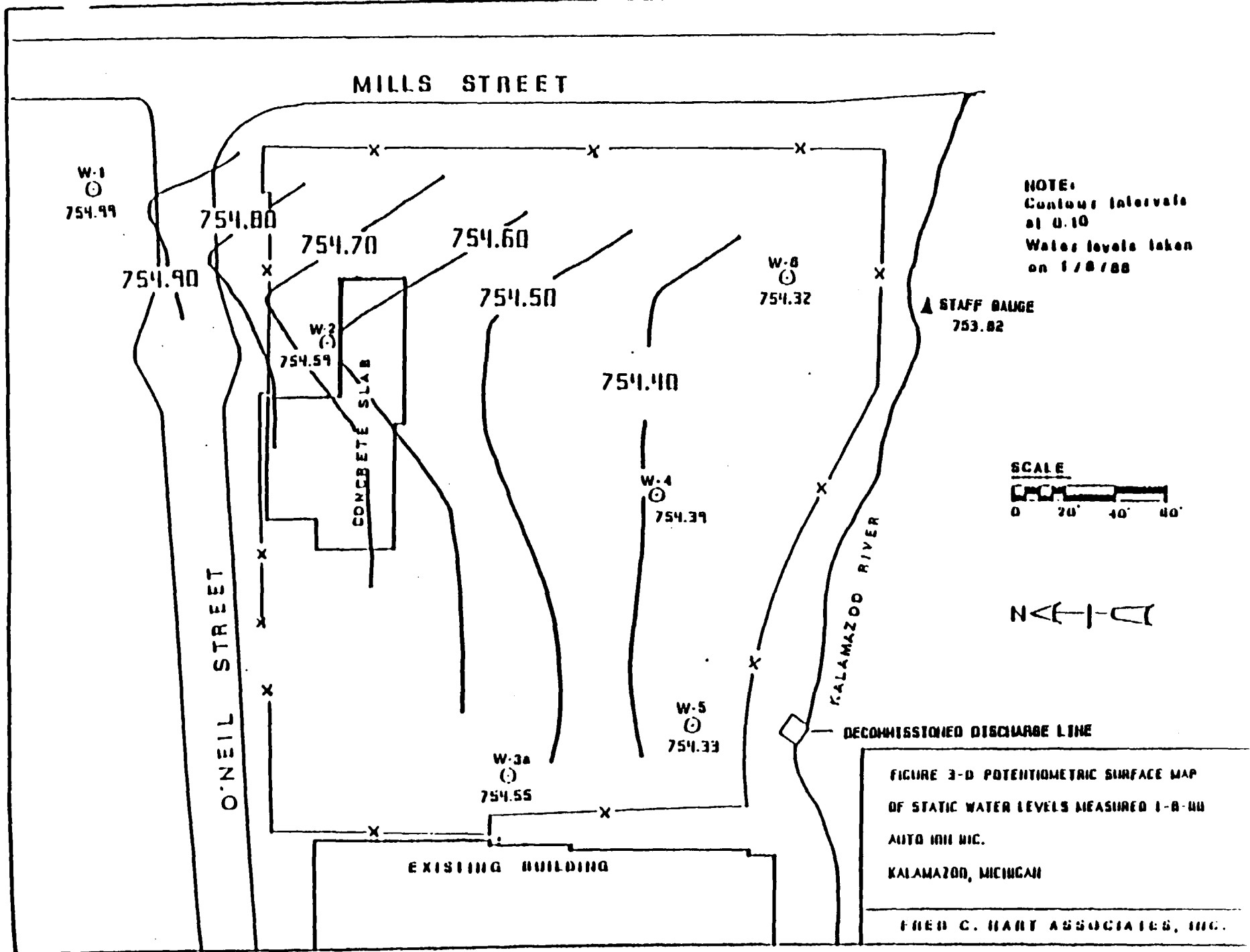


FIGURE 1-16

1.2.5.3 Hydrological Conditions

Groundwater at the Auto Ion site discharges to the Kalamazoo River located adjacent to the site. The groundwater discharges to the river water and is transported downstream. The river discharges to Lake Michigan approximately 40 miles northwest of the site.

At the site, the river is approximately 4 to 10 feet deep and 110 feet wide. The average flow is approximately 1,000 cubic feet per second.

1.2.5.4 Summary

Chemical residuals in groundwater at the Auto Ion site are generally mobile and discharge with the groundwater into the adjacent Kalamazoo River. Various metals, and VOCs to a lesser extent are believed to be partitioning between the groundwater and aquifer materials, however, as dissolved metals are flushed into the river, the partitioning equilibrium should change and allow more of the adsorbed constituents to become mobile. A black silt with peat formation at the top of the water table, along the southern portion of the site, appears to have adsorbed inorganic and organic chemical residuals which are leaching into the groundwater. If portions of this layer are found to contain high levels of contaminants, they will be removed as part of the Operable Unit I Remedial Action. Table 1-5 summarizes the groundwater data collected, to date, from on-site monitoring wells.

1.2.6 Groundwater Baseline Risk Assessment

An endangerment assessment was conducted during the RI. It included an assessment of risks posed by the possible future use of groundwater at the site as a residential drinking water supply and an assessment of river water quality.

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TABLE 1-5

(1)
GROUNDWATER CONSTITUENTS FOUND AT SITE

CONSTITUENTS	ARITHMETIC AVERAGE CONCENTRATIONS ($\mu\text{g/l}$)	RANGE OF CONCENTRATIONS ($\mu\text{g/l}$)	NUMBER OF POSITIVES/PER TOTAL SAMPLES	MDNR ACT 307	
				TYPE B* CRITERIA ($\mu\text{g/l}$)	TYPE C** CRITERIA ($\mu\text{g/l}$)
Aluminum	25,800	<200-74,600	10/21	NA	NA
Arsenic	25.8	<10 - 47	12/20	.02	12,800,000
Barium	2,580	<200 - 4,520	4/21	2,000(5)	NA
Beryllium	58.8	<5 - 111	2/21	NA	NA
Cadmium	16.4	<5 - 39	9/21	4(5)	48,600(6)
Calcium	341,000	132,000 - 961,000	21/21	NA	NA
Total Chromium	534	<10 - 1,370	14/20	7,000(5)	5,900,000(6)
Hexavalent Chromium	78.0	<10 - 220	5/21	100(5)	139,000
Cobalt	142	<50 - 312	4/21	NA	NA
Copper	673	<25 - 1,150	5/17	1,000(5)	1,460,000(6)
Cyanide	443	<10 - 2,850	14/21	100	278,000
Iron	55,100	<100 - 278,000	16/19	NA	NA
Lead	184	<5 - 568	9/19	4(5)	673,000(6)
Magnesium	79,400	24,300 - 245,000	21/21	NA	NA
Manganese	3,680	234 - 38,200	19/19	700	NA
Mercury	1.59	<0.2 - 3.4	7/21	2	90(7)
Nickel	2,900	<40 - 12,300	18/21	100(5)	4,370,000(6)
Potassium	36,900	<5,000 - 118,000	19/21	NA	NA
Silver	11.0	<10 - 11	1/21	40(5)	6,940
Sodium	169,000	66,800 - 551,000	21/21	150,000	NA
Vanadium	121	<50 - 178	3/21	NA	259,000
Zinc	895	<20 - 4,910	13/19	1,000(5)	6,180,000(6)
Chloromethane	25.0	<10 - 38J	2/21	3	NA
Vinyl Chloride	36.8	10 - 48J	4/21	.02	215,000
Methylene Chloride	282	<5 - 560	4/18	5	4,100,000
Trans-1,2-Dichloroethene	116	<5 - 180	6/21	100	20,800,000
1,2-Dichloroethene (total)	73.7	<5 - 180	3/21	NA	NA
1,2-Dichloroethane	45.0	<5 - 45	2/21	.4	38,900,000
Chloroform	41.1	<5 - 95	6/21	6	2,980,000
Trichloroethene	158	<5 - 420	9/21	3	6,530,000
1,2-Dichlorobenzene	23.3	<10 - 28	4/21	600	486,000
2,4,6-Trichlorophenol	22.0	<10 - 22	1/21	3	104,000
Diethylphthalate	22.0	<10 - 22	1/21	6,000	NA
Di-n-butylphthalate (3)	111	<10 - 140B	6/21	700	NA
Bis(2-ethylhexylphthalate (3)	39.4	<10 - 110B	8/21	2	NA

(1) - Background Well MW-1 not included. Includes November 1987, March 1988 and December 1990 sampling events.

(2) - Average of detectable concentrations.

(3) - This compound may not be a contaminant since there is a detection in the associated blank.

(4) - Method Detection Limit.

(5) - Or Background Concentration.

(6) - Assumes hardness of 200 mg/l in surface water.

(7) - Standard is for Methyl Mercury only.

* - Based on acceptable MDNR drinking water regulations.

** - Water quality standard multiplied by Realistic Worst Case Dilution Factor (6.9416 E04). The Dilution Factor was derived by dividing the realistic worst case 95% upper confidence limit concentration of a constituent (see Tables 1-6 and 1-7) by the predicted concentration of the constituent in the river (see Tables 1-17 and 1-18) from the surface water quality model.

This is one methodology to calculate Type C numbers, however, the calculations for Type C criteria used as part of a remedial action may be different. Calculated by Eder Associates.

NA - Not Available

1.2.6.1 Possible Future Drinking Water Scenario

The assessment only used groundwater data from the November 1987 and March 1988 sampling events. The assessment assumed the shallow groundwater would be consumed at a rate of two liters/day by an individual over a 70 year lifetime. The assessment determined that the groundwater would pose an unacceptable level of risk for potential adverse carcinogenic and non-carcinogenic effects.

Chemicals causing the greatest concern for carcinogenic effects included vinyl chloride, arsenic, trichloroethylene, bis(2-ethylhexyl)-phthalate and 1,2-dichloroethane. Cumulative carcinogenic risks were $> 1.0 \times 10^{-3}$.

Chemicals causing the greatest concern for non-carcinogenic effects included arsenic, barium, cadmium, hexavalent chromium, cyanide, lead and nickel. Cumulative risks resulted in hazard index ratios exceeding 12; an acceptable risk can not exceed unity (1).

The risk assessment for this scenario has been revised and is herein documented. This new assessment includes the December 1990 groundwater sampling data, uses new USEPA guidance and the most current toxicity values.

A reasonable maximum exposure case was developed for the potential future use of groundwater at the site as residential drinking water. This case assumes oral ingestion of the shallow groundwater by residents and was developed using USEPA's December 1989 Risk Assessment Guidance for Superfund/Volume I/Human Health Evaluation Manual. Direct contact and inhalation exposure routes for the groundwater were not included since they are expected to be very minor compared to the oral ingestion route which already exceeds acceptable drinking water criteria.

It is important to note that this exposure scenario is extremely unlikely, since the site is in an older industrial area which is serviced by city water. Only the shallow groundwater is impacted, which discharges into the river adjacent to the site. According to the Preamble to the National Contingency Plan (NCP), it should not be necessary to evaluate the groundwater at this site with

a future scenario in which groundwater is used for residential drinking water. City water is already supplied to this area and the installation of new drinking water wells is restricted by the state and county health departments. Only the City of Kalamazoo would be able to obtain a permit to install a drinking water well in this area, in the event that they needed to expand groundwater production for the current water supply system. The city uses a series of criteria to select new drinking water well sites. The first criteria is the absence of any potential source of groundwater contamination in the area, which includes a review of all industrial facilities, CERCLA, and state superfund sites. Even if the Auto Ion site were not present, the City would not develop the groundwater in this area due to other adjacent sites of known contamination, the presence of active industrial facilities and the elevated concentrations of sodium. All future expansion plans for drinking water wells by the city water department are in the outlying township areas, away from the city where the site is located. The groundwater impacted by the Auto Ion site is very small and restricted to shallow groundwater which discharges into the adjacent river. The Preamble to the NCP indicates that future land use scenarios (e.g. shallow groundwater at the Auto ion site being used as drinking water) "... may not be justifiable if the probability that the site will support ...[that] use in the future is small." It further states that "EPA is clarifying its policy of making exposure assumptions that result in an overall exposure estimate that is conservative but within a realistic range of exposure. Under this policy, EPA defines "reasonable maximum" such that only potential exposures that are likely to occur will be included in the assessment of exposures." It is extremely unlikely that the shallow groundwater impacted from the Auto Ion site would ever be used as drinking water.

In accordance with USEPA guidance, a 95% upper confidence limit was determined for concentrations of analytes and compounds identified in the groundwater. An arithmetic mean was calculated for each parameter at each well location using the three sampling events. The arithmetic means concentrations at MW-2, MW-3A, MW-4, MW-5 and MW-6 for inorganics are presented in Table 1-6 and for organics in Table 1-7. MW-1 was not used since this is an

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TABLE 1-6

95% UPPER CONFIDENCE LIMIT CONCENTRATIONS
OF INORGANICS IN GROUNDWATER

	X MW-2 (<u>ug/l</u>)	X MW-3 (<u>ug/l</u>)	X MW-4 (<u>ug/l</u>)	X MW-5 (<u>ug/l</u>)	X MW-6 (<u>ug/l</u>)	X (<u>ug/l</u>)	S (<u>ug/l</u>)	95% UPPER CONFIDENCE LIMIT (<u>ug/l</u>)
Aluminum	48,800	2,210	3,960	3,800	23,300	16,400	20,100	35,500
Antimony	(a)	(a)	(a)	(a)	(a)	-	-	-
Arsenic	17	13	26	21	28	21	6.2	27
Barium	3,020	200	200	200	555	835	1,230	2,000
Beryllium	40	5	5	5	5.5	12	16	27
Cadmium	22	5	9.4	7	15	12	6.9	19
Calcium	245,000	292,000	362,000	256,000	527,000	336,000	116,000	446,000
Total Chromium	657	285	86	463	729	444	265	696
Hexavalent Chromiu	120	13	10	10	10	33	49	80
Cobalt	162	50	50	50	60	74	49	120
Copper	249	200	25	400	334	242	143	378
Cyanide	27	87	950	34	10	220	410	610
Iron	108,000	17,000	14,600	19,600	125,000	56,800	54,800	109,000
Lead	268	20	31	24	211	110	120	220
Magnesium	137,000	29,200	118,000	46,000	125,000	91,000	49,600	138,000
Manganese	13,300	1,360	1,210	1,310	5,660	4,570	5,240	9,560
Mercury	0.6	1.6	0.2	1.0	0.5	0.8	0.5	1.0
Nickel	5,400	668	6,420	1,850	663	3,000	2,720	5,590
Potassium	9,900	26,400	104,000	30,700	11,200	36,400	38,900	73,400
Selenium	(a)	(a)	(a)	(a)	(a)	-	-	-
Silver	(a)	(a)	(a)	(a)	(a)	-	-	-
Sodium	120,000	76,300	388,000	118,000	151,000	171,000	124,000	289,000
Thallium	(a)	(a)	(a)	(a)	(a)	-	-	-
Vanadium	93	50	50	50	78	64	20	83
Zinc	505	414	2,510	454	446	866	920	1,740

(a) = Non-Detectable

- = Not Applicable

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TABLE 1-7

95% UPPER CONFIDENCE LIMIT CONCENTRATIONS
OF ORGANICS IN GROUNDWATER

	X MW-2 (<u>ug/l</u>)	X MW-3A (<u>ug/l</u>)	X MW-4 (<u>ug/l</u>)	X MW-5 (<u>ug/l</u>)	X MW-6 (<u>ug/l</u>)	X (<u>ug/l</u>)	S (<u>ug/l</u>)	95% UPPER CONFIDENCE LIMIT (<u>ug/l</u>)
Chloromethane	10	10	19	10	11	12	3.9	16
Vinyl Chloride	10	10	32	15	10	15	9.5	24
Methylene Chloride	5	7	280	6	5	61	120	180
Trans-1,2-Dichloroethene	5	71	65	5	5	30	35	63
1,2-Dichloroethene (total)	5	14	63	7	5	19	25	43
1,2-Dichloroethane	5	5	18	5	5	8	6	14
Chloroform	14	5	39	5	5	14	15	28
Trichloroethene	5	59	245	8	5	64	104	163
Tetrachloroethene	(a)	(a)	(a)	(a)	(a)	-	-	-
1,2-Dichlorobenzene	10	10	23	10	10	13	5.8	19
2,4-Dimethylphenol	10	10	10	10	10	10(c)	0	10(c)
2,4,6-Trichlorophenol	10	14	10	10	10	11	1.8	13
Diethylphthalate	11	10	10	10	10	10(c)	0.4	10(c)
Di-n-butylphthalate	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)
Bis(2-ethylhexyl)phthalate	(b)	(b)	(b)	(b)	(b)	(b)	(b)	(b)

(a) Only present in upgradient well

(b) Only present when in blank, sampling and/or laboratory contaminant

(c) Equivalent to detection level

upgradient monitoring well and MW-3B was not used since this is an unimpacted deep well. The overall mean and standard deviation of each parameter was then calculated from the five mean concentrations of each on-site shallow well. The 95% upper confidence limit was then calculated from the mean and standard deviation of each parameter using the following equation:

$$UL_{1-\alpha} = \bar{X} + t_{1-\alpha, n-1} \frac{S}{\sqrt{n}}$$

Where:

$UL_{1-\alpha}$	= 95% Upper Confidence Limit
\bar{X}	= Mean chemical concentration in groundwater at the site
S	= Standard Deviation of mean
$t_{1-\alpha, n-1}$	= Value from t-distribution table
n	= Sample size or Number of monitoring wells used (5)
α	= Probability (0.05)

The results are presented in Tables 1-6 and 1-7.

1.2.6.1.1 Non-Carcinogenic Risk Calculations

The average daily intake rate for non-carcinogens was calculated for each parameter which has an oral subchronic and/or chronic reference dose (RfD). Beryllium was not included in the assessment since it was only detected during the November 1987 sampling event; elevated in MW-2 and near the detection limit in MW-6. The Intake was calculated using the following equation:

$$\text{Intake (mg/kg-d)} = \frac{\text{CW} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

Where:

CW =	Concentration of 95% upper confidence limit for chemical in groundwater (mg/l)
IR =	Ingestion Rate (2 liters/day)
EF =	Exposure Frequency (350 days/year)

ED = Exposure Duration (30 years)
BW = Body Weight (70 kg)
AT = Averaging Time (30 years)

All equation variables, except chemical concentration, were taken from USEPA's Interim Final March 25, 1991 Supplemental Guidance/"Standard Default Exposure Factors". The calculated intake is shown in Table 1-8.

A review of oral subchronic and chronic RfDs revealed that the values were the same in almost every case except for a few where the subchronic RfD was less conservative; therefore, only oral chronic RfDs were evaluated. The oral chronic RfD for each parameter is shown in Table 1-8.

The Intake was divided by the RfD to determine whether drinking the groundwater could cause adverse non-carcinogenic health effects for each chemical. This resulting value is known as the hazard index. A hazard index greater than one, or unity, indicates a potential health risk. As shown in Table 1-8, only three chemicals exceeded a hazard index of unity; barium at 1.1, manganese at 2.6 and nickel at 7.5. The combined hazard index of all chemicals of concern equaled 15. Most of that value was due to the three chemicals which exceeded unity. Other chemicals which, by themselves, would not be a concern, but, when added together, significantly increase the total hazard index value include cadmium and arsenic. Other chemicals present also add to the total risk of an adverse response.

1.2.6.1.2 Carcinogenic Risk Calculations

The intake rate for carcinogens was calculated for each parameter which has a slope factor. Beryllium was not included in the assessment since it was only detected in the November 1987 sampling event; elevated in MW-2 and near the detection limit in MW-6. The intake rate was calculated using the following equation:

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TABLE 1-8

CHRONIC NONCARCINOGENIC RISK LEVELS FOR USE OF
GROUNDWATER AS RESIDENTIAL DRINKING WATER

	ORAL INTAKE (mg/kg-d)	ORAL RfD (mg/kg-d)	INTAKE RfD
Arsenic	7.4×10^{-4}	1.0×10^{-3}	7.4×10^{-1}
Barium	5.5×10^{-2}	5.0×10^{-2}	1.1
Cadmium	5.2×10^{-4}	5.0×10^{-4}	1.0
Total Chromium	2.7×10^{-2}	1.0	2.7×10^{-2}
Hexavalent-Chromium	2.2×10^{-3}	5.0×10^{-3}	4.4×10^{-1}
Copper	1.0×10^{-2}	3.7×10^{-2}	2.7×10^{-1}
Cyanide	1.7×10^{-2}	2.0×10^{-2}	8.5×10^{-1}
Manganese	2.6×10^{-1}	1.0×10^{-1}	2.6
Mercury	2.7×10^{-5}	3.0×10^{-4}	9.0×10^{-2}
Nickel	1.5×10^{-1}	2.0×10^{-2}	7.5
Vanadium	2.3×10^{-3}	7.0×10^{-3}	3.3×10^{-1}
Zinc	4.8×10^{-2}	2.0×10^{-1}	2.4×10^{-1}
Methylene chloride	4.9×10^{-3}	6.0×10^{-2}	8.2×10^{-2}
Trans-1,2-Dichloroethene	1.7×10^{-3}	2.0×10^{-2}	8.5×10^{-2}
Chloroform	7.6×10^{-4}	1.0×10^{-2}	7.6×10^{-2}
1,2-Dichlorobenzene	5.2×10^{-4}	9.0×10^{-2}	5.8×10^{-3}
Additive Risk			15

$$\text{Intake (mg/kg-d)} = \frac{\text{CW} \times \text{IR} \times \text{EF} \times \text{ED}}{\text{BW} \times \text{AT}}$$

Where:

CW =	Concentration of 95% upper confidence limit for chemical in groundwater (mg/l)
IR =	Ingestion Rate (2 liters/day)
EF =	Exposure Frequency (350 days/year)
ED =	Exposure Duration (30 years)
BW =	Body Weight (70 kg)
AT =	Averaging Time (70 years)

All equation variables, except chemical concentration, were taken from USEPA's Interim Final March 25, 1991 Supplemental Guidance/"Standard Default Exposure Factors". The calculated Intake Rates are shown on Table 1-9. The slope factors used are also presented on Table 1-9.

The intake rate was multiplied by the oral slope factor to calculate the lifetime cancer risk posed by the residential drinking water scenario for each chemical. The lifetime cancer risk indicates the number of excess cancers which would be expected to occur in a residential population drinking the groundwater over a thirty year period. For example, this level of arsenic would be estimated to result in 5.8 excess cancers for every 10,000 residents drinking the groundwater for thirty years.

USEPA's National Contingency Plan (NCP) has indicated that acceptable lifetime cancer risk levels are generally in the range of 1.0×10^{-4} to 1.0×10^{-6} . As shown in Table 1-9, only two chemicals exceeded this risk range; arsenic at 5.8×10^{-4} and vinyl chloride at 5.3×10^{-4} . Total risk presented by the drinking water scenario is estimated as the total exposure risk, which is 1.2×10^{-3} . The highest cancer risk chemicals other than arsenic and vinyl chloride are trichloroethene, methylene chloride and 1,2-dichloroethane. All carcinogenic chemicals evaluated exceed the 1.0×10^{-6} risk level.

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TABLE 1-9

CARCINOGENIC RISK LEVELS FOR USE OF
GROUNDWATER AS RESIDENTIAL DRINKING WATER

	INTAKE RATE (mg/kg-d)	ORAL SLOPE FACTOR ⁻¹ (mg/kg-d)	LIFETIME CANCER RISK
Arsenic	3.2×10^{-4}	1.8	5.8×10^{-4}
Chloromethane	1.8×10^{-4}	1.3×10^{-2}	2.3×10^{-6}
Vinyl chloride	2.8×10^{-4}	1.9	5.3×10^{-4}
Methylene chloride	2.1×10^{-3}	7.5×10^{-3}	1.6×10^{-5}
1,2-Dichloroethane	1.6×10^{-4}	9.1×10^{-2}	1.5×10^{-5}
Chloroform	3.3×10^{-4}	6.1×10^{-3}	2.0×10^{-6}
Trichloroethene	1.9×10^{-3}	1.1×10^{-2}	2.1×10^{-5}
2,4,6-Trichlorophenol	1.5×10^{-4}	1.1×10^{-2}	1.6×10^{-6}
Additive Risk			1.2×10^{-3}

1.2.6.2 Impact of Groundwater on the Kalamazoo River

1.2.6.2.1 MDNR Investigations of the Kalamazoo River

The MDNR has undertaken several studies of the Kalamazoo River which have included the portion of the river passing through the City of Kalamazoo since 1971. A biological survey was conducted during the summer of 1971 in an attempt to identify portions of the river where aquatic biological communities were being adversely impacted from surface water pollution; Biological Survey of the Kalamazoo River/June-August, 1971, MDNR, April 1972. The survey reported the following findings regarding the City of Kalamazoo area:

- 1) Both macroinvertebrates and fish populations were found to be very substantially degraded in the Main Branch from the City of Kalamazoo downstream to Lake Allegan, the result of numerous municipal and industrial waste discharges;
- 2) Taint tests conducted on four species of fish collected, indicated a significant degradation in both taste and aromatic qualities downstream from the City of Kalamazoo;
- 3) Downstream from the City of Kalamazoo, PCB concentrations in fish increased sharply;
- 4) The primary area of biological and water quality degradation in the Kalamazoo River is the river reach from The City of Kalamazoo to Lake Allegan. The greatest impact on this reach is from the cities of Kalamazoo, Parchment and Otsego;
- 5) The highest impact to water quality in the City of Kalamazoo area was immediately below the City of Kalamazoo's POTW. Extremely poor water quality conditions were encountered below the POTW discharge. Water turbidity was very severe and anaerobic sludge bed development was extensive. The benthic community development was severely degraded, consisting almost entirely of high numbers of sludgeworms and midges; and,
- 6) Metal analysis of sediments identified the highest zinc and lead concentrations of the survey at the first station downstream from the City of Kalamazoo. Cadmium, chromium, copper

and nickel were also relatively high at this station. The study identified the following concentration ranges for metals in sediments over the entire river:

<u>Metal</u>	Concentration
	<u>Range (mg/kg)</u>
Arsenic	0.8 - 4.2
Cadmium	0.2 - 1.4
Chromium	<10 - 48
Copper	<1 - 50
Lead	16 - 125
Mercury	<0.1 - 0.44
Nickel	3.0 - 20
Zinc	27 - 165

Note: results believed to be on wet weight basis

In August of 1971, the MDNR conducted an investigation of the Auto Ion Chemical Company; Investigation of Auto Ion Chemical Company/ Kalamazoo, Michigan/August 19, 1971, MDNR, September 1971. The investigation was prompted by previous observations by MDNR staff of the loss of chromium, copper, cyanide, nickel and oil to the Kalamazoo River at a seepage area near the southwest boundary of the Auto Ion property. The investigation made the following determinations (Note - results reported on wet weight basis):

- 1) High concentrations of chromium (650 - 800 mg/kg), copper (68 - 140 mg/kg) and nickel (160 - 320 mg/kg) were identified in sediments immediately adjacent to two suspected discharge locations along the Auto Ion property;
- 2) Elevated metal concentrations were not identified in sediment samples located 10 and 30 yards downstream from Auto Ion;
- 3) Background concentrations of metals in sediments upstream from the site were determined to be as follows:

<u>Metal</u>	<u>Concentration</u> <u>Range (mg/kg)</u>
Cadmium	<2
Chromium	<8 - 40
Copper	23 - 51
Nickel	<20
Zinc	120 - 160

- 4) Although elevated metals were identified in soils on both the Acolor and Auto Ion properties, the higher concentrations on the Auto Ion property were believed to be the most significant source of these constituents in the seepage area and river sediments;
- 5) High concentrations of oil were found in all sediment samples upstream and downstream of Auto Ion, indicating an upstream source. This was substantiated by visual observation of surface oil across the entire river at the Mill Street Bridge;
- 6) The MDNR speculated that Auto Ion was also a periodic source of oil seepage into the river; and,
- 7) The MDNR believed that macroinvertebrate populations downstream of Auto Ion demonstrated stress from poor water quality as compared to those upstream of the site. However, the limited number of samples (one upstream and one downstream) and differences in substrates make this conclusion speculative.

In July and October 1982, the MDNR conducted a water quality survey of the Kalamazoo River from the City of Kalamazoo to the City of Allegan; Macroinvertebrate and Sediment Chemistry Survey of the Kalamazoo River, Kalamazoo to Allegan, July 22 and October 7, 1982, MDNR, November 1982. This investigations made the following findings which pertain to river quality in the City of Kalamazoo area:

- 1) Water quality between Morrow Dam and the Portage Creek confluence (this river reach includes the Auto Ion site) was good. Benthic macroinvertebrate communities were typical of those found in good quality warm water streams;
- 2) Poor water quality stream conditions were found below the Kalamazoo POTW. Macroinvertebrate communities in this reach, below the City of Kalamazoo, exhibited stress typical of organically enriched sediments;
- 3) Paper fiber deposits and high levels of PCBs were found in sediments of Portage Creek and in the Kalamazoo River below the confluence with Portage Creek; and,
- 4) Sediment mercury concentrations increased from <0.25 mg/kg upstream of Portage Creek to 3.6 mg/kg, one kilometer downstream of the City of Kalamazoo POTW.

In 1987, the MDNR prepared a Remedial Action Plan (RAP) for the Kalamazoo River. The primary concern was for PCBs, especially between Portage Creek in the City of Kalamazoo and Lake Michigan. This RAP included a model of the river which describes the physical characteristics of the river in the City of Kalamazoo as an erosional zone.

Subsequently, additional sampling of the Kalamazoo River upstream of the Portage Creek confluence for PCBs, by the MDNR, has identified PCBs in the river from a Georgia Pacific site, known as the Willow site. This site is reportedly a short distance upstream of the Auto Ion site.

1.2.6.2.2 Auto Ion Remedial Investigation of the Kalamazoo River

The Auto Ion Remedial Investigation (RI) included a hydrological characterization of the Kalamazoo River, sediment and surface water sampling upstream, adjacent and downstream of the Auto Ion site.

1.2.6.2.2.1 Hydrological Characterization of the Kalamazoo River

The Kalamazoo River passes through the City of Kalamazoo. In this area the river is approximately 110' wide and 5' deep with a primarily sandy bottom. A USGS stream gauge is located a short distance upstream in the City of Comstock. The average flow of the river along this reach is approximately 850 ft³/s. Over a period of 46 measured years, the highest flow was 6,910 ft³/s and the lowest was 119 ft³/s.

The Kalamazoo River is a gaining stream which receives groundwater discharge. Generally groundwater flows towards the river and/or its tributaries from adjacent lands which comprise the river drainage basin. Groundwater elevations at the Auto Ion site have shown that during periods of high river flow from storm events, groundwater flow reversals occur and groundwater flows away from the river. This phenomena is commonly referred to as bank storage. These flow reversals are limited to land areas immediately adjacent to a river and do not extend far inland (Freeze and Cherry, Groundwater, pp. 226-227 and 230, Prentice-Hall, Inc., 1979). These flow reversals are also temporary in nature, generally lasting only a few to several days while the river crests in response to major storm events and/or snow melts (Freeze and Cherry, Groundwater, pp. 226-227 and 230, Prentice-Hall, Inc., 1979). Groundwater elevation monitoring at the site has shown that these flow reversals appear to be limited to storm event periods (see Figures 1-6 to 1-12 and February 1991 draft RI Addendum Report, p. 19).

In October 1992, a program was conducted, at the request of the USEPA, to evaluate the impact of groundwater from the Auto Ion site on the Kalamazoo River. The program was conducted by Conestoga Rovers & Associates and Dr. Peter Meier of the University of Michigan. Seven sampling locations, upstream, downstream, and proximal to the Auto Ion site, were selected. Samples were collected and split in the field for various physical and chemical parameters. Additionally, approximately 20 samples were collected for macroinvertebrate identification.

The program identified a diverse and abundant macroinvertebrate population. There was no statistically significant difference in survival of target species observed in samples from the river, including samples collected near the Auto Ion site, as compared to the control sample during a 10 day exposure. The chemical results indicated that contaminants are present in the Kalamazoo

River sediments upstream of, adjacent to, and downstream of the Auto Ion site. Based on observations made during the field activities, it appears that nearby industrial activities have resulted and may still be resulting in releases of contaminants to the river. Therefore, it was concluded in the Sediment Toxicity Evaluation Report previously approved by USEPA that potential impact of groundwater at the Auto Ion site to water in the Kalamazoo River would not be a measurable effect on water quality. Also, the report stated that there is no discernible impact on the aquatic macroinvertebrate community of the Kalamazoo River due to the discharge of groundwater from the Auto Ion site to the river.

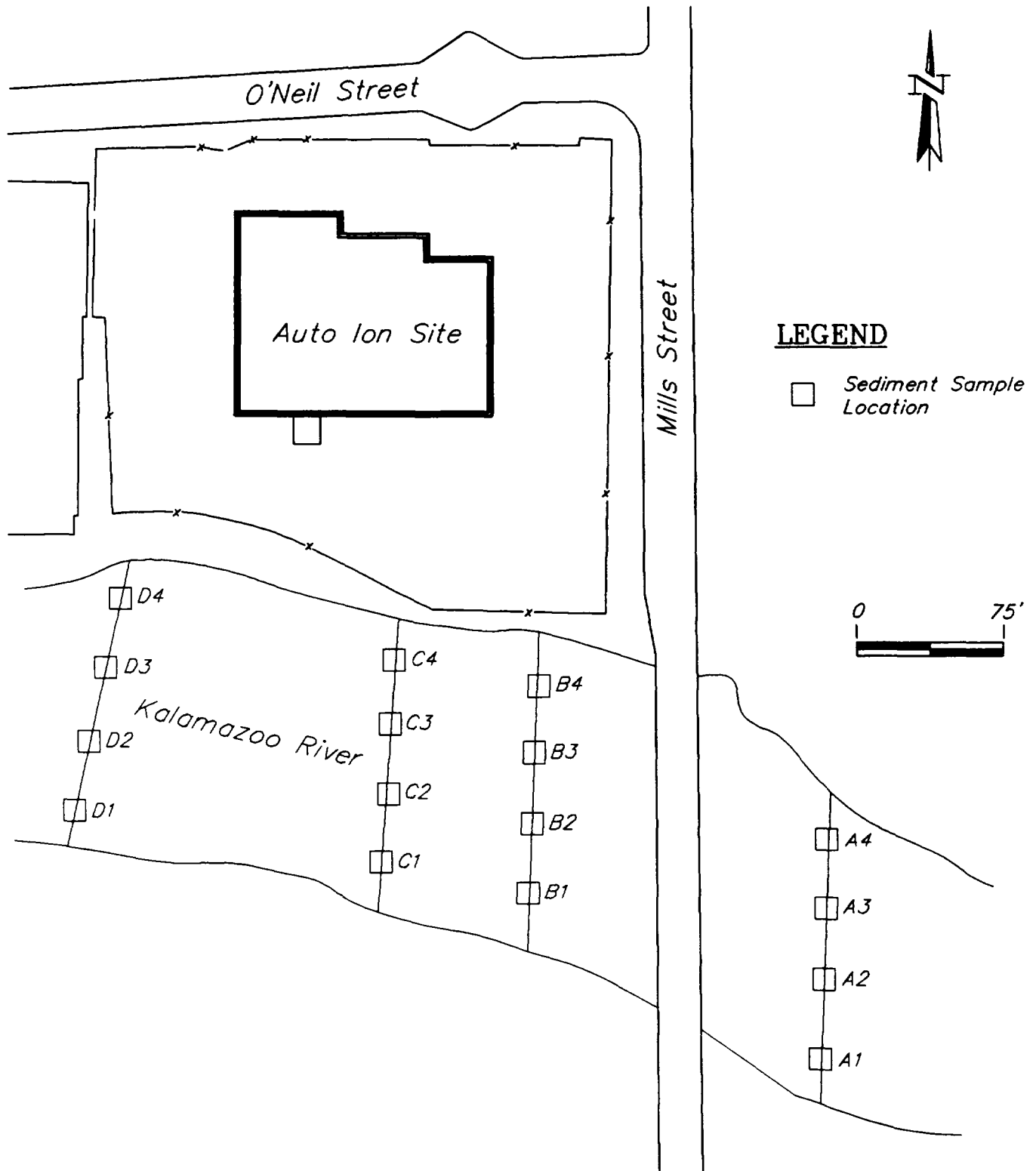
1.2.6.2.2.2 Sediment Sampling Results

During the RI sediment samples were collected along six river transects. Figure 1-18 illustrates four of the transects; Transect A is upstream of the site, transects B and C are adjacent to the site, and Transect D is immediately downstream of the site. Transects E and F are 0.5 mile and 1 mile, respectively, downstream of the site. Transect E is downstream of the point where Portage Creek converges with the Kalamazoo River. Transect F is downstream of the City of Kalamazoo POTW discharge. An attempt was made to collect sediment samples from four equally spaced locations along each transect as shown in Figure 1-18.

Figure 1-19 shows the approximate cross section geometry and area for each of the transect locations. Based on the cross section areas and average river flow of (850 ft³/s), the estimated average velocity for each transect location is presented below:

Transect A	0.78 ft/s
Transect B	1.4 ft/s
Transect C	1.4 ft/s
Transect D	1.1 ft/s
Transect E	2.2 ft/s
Transect F	1.0 ft/s

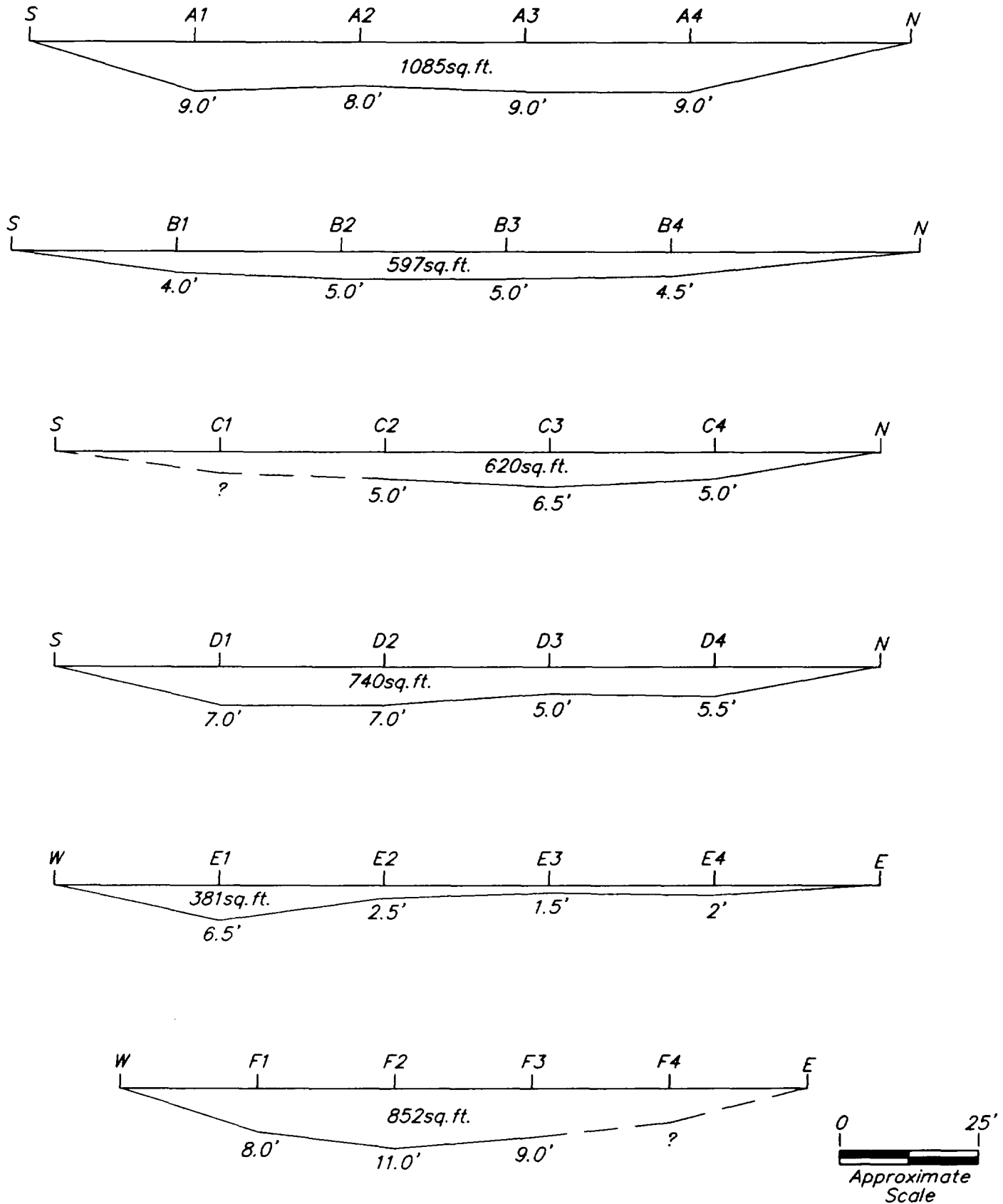
These velocities are characteristic of a scouring river reach. Only minor deposition would be expected along this portion of the river.



SEDIMENT AND SURFACE WATER SAMPLE LOCATIONS TRANSECTS A-D

AUTO ION SITE
 KALAMAZOO, MICHIGAN

FIGURE 1-19



TRANSECTS A-F CROSS SECTIONS

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Transect A has the lowest velocity and would be expected to contain the largest amount of deposition; visual observation of this sediment generally characterized it as fine to course sand and silt. Transects B and C would have the highest velocities in the immediate site area and would be expected to be the least depositional; visual observation of these sediments generally contained medium to course sand and gravel with some silt at sporadic locations. Transect D has an intermediate velocity and was visually characterized as generally containing sand and gravel, silty organic muck was identified at one location (D1). Transect E has the highest velocity and was visually characterized as sand and gravel; the main channel on the western side (E1) contained only gravel and the slowest portion of the channel (E4) contained some silt. Transect F has the second lowest velocity; it generally contained sand, leaves, muck, some silt and gravel.

Inorganics - Inorganic sediment results are contained in Table 1-10. Sediment analytical results are often good indicators of historical water quality problems or events which may not be present in surface water at the time of sampling. Samples from transect A (A1, A2, A3 and A4) represent background conditions at the site and contain relatively low levels of inorganics. These results are reported on a dry weight basis and would therefore be expected to contain concentrations of up to approximately 5 to 20 times higher than wet weight samples which commonly contain 20% to 5% solids. If we compare these levels to site specific background levels previously collected by the MDNR in 1971 we see that background concentrations for chromium, copper and zinc appear to have decreased substantially. The MDNR 1971 Auto Ion background river concentrations are shown below:

<u>Metal</u>	Concentration
	<u>Range (mg/kg)</u>
Cadmium	<2
Chromium	<8 - 40
Copper	23 - 51
Nickel	<20
Zinc	120 - 160

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TABLE 1-10

INORGANIC SEDIMENT RESULTS (mg/kg dry weight)

	<u>UPSTREAM</u>				<u>ADJACENT</u>					<u>ADJACENT</u>				<u>IMMEDIATELY DOWNSTREAM</u>				<u>0.5 MILE DOWNSTREAM</u>			<u>1 MILE DOWNSTREAM</u>		
	A1	A2	A3	A4	B1	B1-DUP	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E2	E3	E4	F1	F2	F3
Aluminum	959	952	1,160	1,380	1,770	1,160	1,200	2,620	2,200	960	739	663	738	1,080	1,930	1,620	1,320	2,710	2,870	1,410	2,550	1,460	2,090
Antimony	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R
Arsenic	<2.0	<2.0	<2.0	2.0	<2.0	<2.0	<2.0	5.6	<2.0	<2.0	2.5	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	9.0	5.9	3.2	6.5	2.8	<2.0
Barium	<40	<40	<40	<40	<40	<40	<40	62	<40	<40	<40	<40	<40	<40	<40	<40	95	65	<40	<40	<40	<40	<40
Beryllium	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Cadmium	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1.6	2.0	3.8	<1.0	<1.0	<1.0
Calcium	47,600	23,900	29,400	42,800	39,700	30,700	46,000	81,700	45,600	37,500	82,100	37,100	40,300	26,900	62,400	68,500	35,100	24,600	51,000	46,700	23,600	29,600	35,600
Chromium (total)	17	19	19	16	19	18	17	23	24	19	13	12	18	17	16	23	113	27	31	26	54	22	23
Cobalt	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
Copper	<5.0	<5.0	14	6	10	6.4	<5.0	14	11	<5.0	13	6.4	6.6	37	<5.0	<5.0	117	45	66	13	44	11	9.0
Cyanide	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Iron	3,670	3,810	4,340	5,780	14,900	6,560	4,980	13,200	19,100	6,190	4,750	4,160	5,910	4,970	5,580	7,730	11,100	16,700	16,200	6,760	10,800	6,920	6,850
Lead	15	18	11	13	35	20	R	208	63	43	19	8	43	31	8.6	24	71	77	99	75	189	31	26
Magnesium	9,020	3,670	5,500	9,290	12,300	4,660	13,100	36,500	9,690	7,500	14,000	8,430	9,250	7,540	11,200	24,800	6,670	7,670	8,420	8,370	4,530	6,220	10,200
Manganese	207	259	256	192	249	189	268	294	282	177	243	131	203	189	205	274	173	415	228	140	336	172	142
Mercury	<0.1	<0.1	<0.1	<0.1	0.20	<0.1	0.10	<0.1	0.70	<0.1	<0.1	0.10	<0.1	2.9	0.20	0.20	<0.1	0.14	0.18	0.22	0.47	<0.1	<0.1
Nickel	<8.0	<8.0	16	<8.0	<8.0	<8.0	<8.0	12	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	<8.0	18	19	17	14	12	<8.0	13
Potassium	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
Selenium	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Silver	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R	<2.0	2.1	3.0	<2.0	<2.0	<2.0
Sodium	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000	<1,000
Thallium	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	0.5	<2.0	<2.0	<2.0	<2.0
Vanadium	<10	<10	<10	<10	<10	<10	<10	15	<10	<10	<10	<10	<10	<10	<10	<10	<10	14	<10	<10	<10	<10	<10
Zinc	31	38	32	23	52	46	25	82	74	56	27	17	51	53	26	44	81	70	82	43	160	39	37

R - Data Unusable
6840317b110

This difference would be even more pronounced by an approximate order of magnitude if the MDNR results were converted from a wet weight basis to dry weight basis for accurate comparison. Since both sets of results are from upstream of Mill Street Bridge, it appears that these sediments have drastically improved in quality since 1971.

Sediment samples from Transect B (B1, B2, B3 and B4), adjacent to the Auto Ion site, contain slightly elevated levels of aluminum, arsenic, barium, calcium, copper, chromium, iron, lead, magnesium, manganese, mercury, vanadium and zinc. The most elevated levels for each of these analytes were found in samples B3 and/or B4 which are on the north side of the river closest to the Auto Ion site. The sediments from the north side of the river contained some silt which was absent on the south side of the river.

Sediment samples from Transect C (C1, C2, C3 and C4), adjacent to the Auto Ion site, contain very slightly elevated levels of arsenic, calcium, iron, lead, magnesium, mercury and zinc. Most of the elevated levels for these analytes were found in samples on the south side of the river farther away from the Auto Ion site. This is unexpected since the sediments from the south side of the river were described as containing only coarse gravel, indicating a high scouring area.

Sediment samples from Transect D (D1, D2, D3 and D4), immediately downstream of the Auto Ion site, contain slightly elevated levels of aluminum, barium, calcium, chromium, copper, iron, lead, magnesium, mercury and zinc. Most of the elevated levels for these analytes were found in samples on the north side of the river in samples D3 and/or D4 closest to the Auto Ion site. From the cross section of this transect (see Figure 1-19) it appears that the north side of the channel would be the slowest portion, being on the inside of a slight turn in the river.

In 1971 the MDNR found high levels of chromium (650 - 800 mg/kg), copper (68 - 140 mg/kg) and nickel (160 - 320 mg/kg) in sediments adjacent to the Auto Ion site. If these were adjusted to a dry weight basis for accurate comparison these levels would be expected to increase by approximately an order of magnitude. Current sediment concentrations adjacent to and immediately downstream from the Auto Ion site appear to have substantially decreased in concentration compared to the upgradient and downgradient samples from 1971.

Sediment samples from Transect E (E2, E3 and E4), downstream from the convergence with Portage Creek, contain a slight to moderately elevated levels of aluminum, arsenic, barium, cadmium, calcium, chromium, copper, iron, lead, manganese, magnesium, mercury, silver, thallium, vanadium and zinc. This portion of the river receives numerous industrial outfalls between the Auto Ion site and this location. These sediments exhibit an overall higher level of contamination compared to the background concentrations (Transect A). Previous studies conducted by the MDNR have identified Portage Creek as a major source of industrial pollutants to the Kalamazoo River.

Sediment samples from Transect F (F1, F2 and F3), downstream of the city POTW discharge, contain slightly elevated levels of aluminum, arsenic, chromium, copper, iron, lead, manganese, mercury and zinc. This portion of the river is also impacted from the city POTW which the MDNR has historically found to be a major source of pollution in the Kalamazoo River.

Compared to previous MDNR data collected in the 1970s, sediments in this portion of the Kalamazoo River appear to have improved remarkably. The data from transects E and F can not be accurately compared to transects B, C and D for the purpose of evaluating impacts from the Auto Ion site since there are numerous industrial discharges between these locations.

Organics - Organic sediment results are contained in Table 1-11. Sediment analytical results are often good indicators of historical water quality problems or events which may not be present in surface water at the time of sampling. Samples from transect A (A1, A2, A3 and A4) represent background conditions at the site and contain low concentrations of acetone in one sample, very low concentrations of polynuclear aromatic hydrocarbons (PAHs) in two of the samples and higher concentrations of bis(2-ethylhexyl) phthalate in all four samples. Acetone is a common laboratory contaminant, where it is used as a cleaning solvent, and may not be representative of the sediment sample. Bis(2-ethylhexyl)phthalate is also a common laboratory/sampling contaminant from samples coming in contact with plastic equipment, including sampling gloves. It may not be representative of the sediment samples. If it is representative, an upstream source of the compound must be present. PAHs are common residuals of oil, this is probably the most likely source of these compounds since the MDNR found oil in all sediment samples collected in this reach of the river in 1971. PAHs could also be present from coal cinders/ash from previous power

plant operations at the site, steam locomotives and railroad ties from the railroad yard upstream of the site and other fossil fuel sources.

Samples from Transect B (B1, B2, B3 and B4), adjacent to the Auto Ion site, contain a very low concentration of a PAH compound in one sample (B1), moderate levels of PAHs in one sample (B4) and bis(2-ethylhexyl)phthalate in all samples at similar concentrations as background. Again the PAHs are probably residues from previous oil contamination in the river. The highest concentration was found on the north side of the river, closest to the Auto Ion site, which is where silt was identified in the sediments. No silt was identified in samples from the south side of the river. The bis(2-ethylhexyl)phthalate appears to be from the same source as in the background transect (laboratory/sampling contamination or upstream source).

Samples from Transect C (C1, C2, C3 and C4), adjacent to the Auto Ion site, contain moderate levels of PAHs in one sample (C2) and bis(2-ethylhexyl)phthalate in all samples at table 1-11 similar concentrations as background. Again the PAHs are probably residues from previous oil contamination in the river. The PAHs were only found in a sample on the south side of the river farther away from the Auto Ion site. This is unexpected since the sediments from the south side of the river were described as containing only coarse gravel, indicating a high scouring area. The bis(2-ethylhexyl) phthalate appears to be from the same source as in the background transect (laboratory/sampling contamination or upstream source).

Samples from Transect D (D1, D2, D3 and D4), adjacent to the Auto Ion site, contain very low concentrations of PAHs in two samples (D1 and D3), moderate levels of PAHs in one sample (D4), a very low level of 2-butanone in one sample (D2), low to moderately high levels of PCBs in two samples (D3 and D4) and bis(2-ethylhexyl)phthalate in all samples at similar concentrations as background. Again the PAHs are probably residues from previous oil contamination in the river. PCBs have been found in this section of the Kalamazoo River by the MDNR. Several sources have been suspected including, a large PCB site (Willow site) identified by the MDNR, which is located upstream of the Auto Ion site. A copy of the MDNR report which presents these sediment PCB results, has not been obtained yet. The highest concentrations of PAHs and PCBs were found on the north side of the river, closest to the Auto Ion site. From the cross section of this transect (see Figure 1-19) it appears that the north side of the channel would be the slowest

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TABLE 1-11

ORGANIC SEDIMENT RESULTS (ug/kg dry weight)

	<u>Upstream</u>				<u>Adjacent</u>					<u>Adjacent</u>				<u>Immediately Downstream</u>				<u>0.5 Mile Downstream</u>			<u>1 Mile Downstream</u>		
	A1	A2	A3	A4	B1	B1-D	B2	B3	B4	C1	C2	C3	C4	D1	D2	D3	D4	E2	E3	E4	F1	F2	F3
Acetone	R	R	68	R	R	<10	R	R	R	R	R	R	<10	R	R	R	R	<10	<10	R	<10	<10	16
2-Butanone	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	<10	13	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	<330	<330	<330	<330	R	R	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	330	410	1,300	430	<330
2-Methylnaphthalene	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	R	<330	<330	<330	640	430	<330
Acenaphthylene	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	900	<330	<330
Acenaphthene	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	330	<330	<330	<330	<330
Fluorene	<330	<330	<330	<330	R	R	<330	<330	<330	<330	740	<330	<330	<330	<330	<330	<330	<330	380	540	1,600	<330	<330
Phenanthrene	<330	360	<330	<330	R	R	<330	<330	1,600	<330	3,300	<330	<330	370	<330	360	2,200	1,400	3,300	3,100	7,300	1,400	<330
Anthracene	<330	<330	<330	<330	R	R	<330	<330	<330	<330	810	<330	<330	<330	<330	<330	400	350	630	810	2,100	350	<330
Fluoranthene	<330	410	410	<330	R	R	<330	<330	1,300	<330	3,000	<330	<330	490	<330	<330	1,400	2,000	4,800	3,600	9,400	2,200	<330
Pyrene	<330	<330	<330	<330	R	R	<330	<330	830	<330	1,900	<330	<330	330	<330	<330	960	1,100	2,300	1,800	<330	910	<330
Benzo(a)anthracene	<330	<330	<330	<330	R	<330	<330	<330	460	<330	2,000	<330	<330	<330	<330	<330	880	780	2,400	1,400	4,600	1,000	<330
Chrysene	<330	<330	<330	<330	R	R	<330	<330	460	<330	1,900	<330	<330	<330	<330	<330	760	780	2,300	1,300	<330	870	<330
Benzo(b)fluoranthene	<330	<330	<330	<330	R	R	<330	<330	710	<330	2,100	<330	<330	<330	<330	<330	600	870	3,200	1,300	<330	690	<330
Benzo(k)fluoranthene	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	810	<330	<330	<330	<330	<330	1,000	<330	<330	<330	7,000	480	<330
Benzo(a)pyrene	<330	<330	<330	<330	R	R	<330	<330	420	<330	1,600	<330	<330	<330	<330	<330	680	650	2,200	1,300	2,600	780	<330
Indeno(1,2,3-cd)pyrene	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	1,400	770	<330	610	<330
Dibenzo(a,h)anthracene	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	420	<330	<330	<330	<330
Benzo(g,h,i)perylene	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	1,200	590	<330	520	<330
Dibenzofuran	<330	<330	<330	<330	450	<330	<330	<330	<330	<330	430	<330	<330	<330	<330	<330	<330	<330	<330	<330	900	<330	<330
3,3'-Dichlorobenzidine	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	<660	1,100	<660	<660
Di-n-butylphthate	<330	<330	<330	<330	R	R	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	580	520	<330
Bis(2-ethylhexyl)phthalate	680	2,000	2,000	880	2,400	1,800	1,300	3,700	1,600	830	1,600	1,100	1,300	690	580	710	760	1,100	<330	<330	1,800	1,700	660
Dimethylphthalate	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	<330	390	<330
Aroclor-1242	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80	<80	1,200	<80	<80	<80	<80	16,000	<80	<80
Aroclor-1254	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	1,500	420	<160	<160	<160	<160	<160	<160
Aroclor-1260	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	<160	4,700	<160	<160

R=Unuseable data

D=Duplicate

Note: All other USEPA Target compound List (TCL) volatile organics, semi-volatile organics and pesticides were non-detectable.

portion, being on the inside of a slight turn in the river. The source of the near detection limit concentration of 2-butanone is unknown. The bis(2-ethylhexyl) phthalate appears to be from the same source as in the background transect (laboratory/sampling contamination or upstream source).

Sediment samples from Transect E (E2, E3 and E4), downstream from the convergence with Portage Creek, contain moderate levels of PAHs in all sample locations and bis(2-ethylhexyl)phthalate in one sample (E2) at similar concentrations as background. Again the PAHs are probably residues from previous oil contamination in the river. This portion of the river receives numerous industrial outfalls between the Auto Ion site and this location. These sediments exhibit an overall higher level of degradation from the background concentrations (Transect A). Previous studies conducted by the MDNR have identified Portage Creek as a major source of industrial pollutants to the Kalamazoo River. The bis(2-ethylhexyl) phthalate appears to be from the same source as in the background transect (laboratory/sampling contamination or upstream source).

Sediment samples from Transect F (F1, F2 and F3), downstream of the city POTW discharge, contain low to moderate levels of PAHs in all sample locations, a very low level of acetone in one sample (F3), high levels of PCBs in one sample (F1), low levels of 3,3'-dichlorobenzidine, di-n-butylphthalate and dimethylphthalate in sample locations F1 and/or F2. Bis(2-ethylhexyl)phthalate was found in all samples at similar concentrations as background. Again the PAHs are probably residues from previous oil contamination in the river. PCBs have been found throughout this section of the Kalamazoo River from several known sources. The bis(2-ethylhexyl)phthalate appears to be from the same source as in the background transect (laboratory/sampling contamination or upstream source). The acetone and other phthalate compounds may also be from laboratory and/or sampling contamination. This portion of the river is also impacted from the city POTW which the MDNR has historically found to be a major source of pollution in the Kalamazoo River.

The data from transects E and F can not be accurately compared to transects B, C and D for the purpose of evaluating impacts from the Auto Ion site since there are numerous industrial discharges between these locations.

Summary of Sediment Data - Sediments upstream of the Auto Ion site are generally characterized as sand and silt. Sediments adjacent to and immediately downstream of the Auto Ion site are generally characterized as containing sand and gravel with minor amounts of silt at a few locations. River velocities increase below the Mill Street bridge due to a reduction in the size of the river channel. Average velocities are characteristic of a scouring river reach.

Background concentrations of metals, upstream of Mill Street Bridge, are generally low and are characteristic of good water quality conditions. Background concentrations of organics are generally characteristic of good water quality conditions, except for a few compounds. Low levels of PAHs were identified which are probably residues of oils which were previously observed in these sediments. One sample contained a low level of acetone and all samples contained moderate levels of bis-2-(ethylhexyl)phthalate. These may be laboratory/sampling contaminants or there may be an upstream source of phthalates.

Sediment samples adjacent and immediately downstream of the Auto Ion site contained slightly elevated levels of several metals at various locations, low to moderate levels of PAHs at a few sporadic locations, low to moderate levels of PCBs at two locations, a very low concentration of 2-butanone at one location and bis-2-(ethylhexyl)phthalate at all locations at background concentrations. Elevated metals could be from numerous sources, such as the old municipal landfill on the south side of the river and/or the storm drain below the Mill Street Bridge, upstream discharges and previous activities at the Auto Ion site. The PAHs are possibly residues of oils which were previously observed in these sediments. The PCBs are possibly from an upstream source. The bis(2ethylhexyl)phthalate is possibly from the same source as in the background samples.

Transects E and F generally contained a greater variety and higher levels of inorganics and organics. However, the data from these transects can not be accurately compared to transects B, C and D for the purpose of evaluating impacts from the Auto Ion site since there are numerous industrial discharges between these locations.

In comparison to sediment samples collected by MDNR in 1971, all sediments (upstream, adjacent to and immediately downstream from the Auto Ion site) have substantially improved in

quality. This is probably due to improved water quality (source reduction), scouring of sediments along this portion of the river and biodegradation (e.g., organics).

1.2.6.2.2.3 Surface Water Sampling Results

Surface water was sampled upstream and downstream of the site on two occasions during the RI; October 1987 and in November 1991. The sampling events were designed to determine the impact of the Auto Ion site on surface water quality.

The October 1987 sampling event was reportedly conducted during a period of high river flow; the exact date and river flow are unknown. Water samples were collected at two upstream (A1 and A4) and two downstream (D1 and D4) locations (see Figure 1-18). The results are presented in Table 1-12. Reproduction of concentrations between the two sample locations collected at each transect were good, as would be expected for a river of this size. Several constituents increased in concentration at the downstream locations; acetone, aluminum, cadmium, calcium, chromium, copper, iron, lead, manganese, nickel and silver. Sodium and bis(2-ethylhexyl)phthalate decreased in concentration. Some of the constituents which increased in the downstream sample were found to be elevated in the immediately adjacent and downstream sediment samples; others were not. The river water velocity between the upgradient and downgradient sample locations almost doubles (see Section 1.2.6.2.2.2). The increased water velocity between the sampling locations would increase the scouring of the river sediments, especially during the reported high river flow. Consequently, concentrations of constituents in the sediments would be expected to develop an increase in the downstream water samples. This is possibly an explanation for the increased concentrations downstream of the site.

Other suspected sources of the increased concentrations might include groundwater discharging from the Auto Ion site, groundwater discharging from the old municipal landfill on the south side of the river and/or the storm water drain below Mill Street Bridge. It is unlikely that groundwater would be discharging from either side of the river if the river flow was high, as reported. It is more likely that river water was discharging into the river banks under high flow conditions causing a reversal of flow. Modeling data presented in Section 1.2.6.2.3 of this Baseline Risk Assessment, demonstrates that concentrations in groundwater at the Auto Ion site could not

Auto Ion Site
Kalamazoo, Michigan

Table 1-12

Surface Water Sampling Results
October 1987

	<u>Upstream</u>			<u>Downstream</u>	
	A1	A4	A4-D	D1	D4
Acetone	<10	<10	<10	44	20
Bis(2-ethylhexyl)phtalate	420B	300B	96B	94B	140B
Aluminum	<200	<200	<200	220	200
Antimony	<60	<60	<60	<60	<60
Arsenic	<10	<10	<10	<10	<10
Barium	<200	<200	<200	<200	<200
Beryllium	<5	<5	<5	<5	<5
Cadmium	<5	<5	<5	13	12
Calcium	74,000	73,900	72,600	76,800	77,000
Chromium (total)	<10	<10	<10	39	37
Chromium (hex)	<10	<10	<10	<10	<10
Cobalt	<50	<50	<50	<50	<50
Copper	<25	<25	<25	32	32
Cyanide	R	R	R	R	R
Iron	460	360	290	530	390
Lead	<5	<5	<5	190	200
Magnesium	22,200	22,200	21,800	22,200	22,300
Manganese	49	43	37	58	48
Mercury	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	<40	<40	<40	60	61
Potassium	<5,000	<5,000	<5,000	<5,000	<5,000
Selenium	<5	<5	<5	<5	<5
Silver	<10	<10	<10	27	28
Sodium	17,100	17,200	16,800	15,900	15,700
Thallium	<10	<10	<10	<10	<10
Vanadium	<50	<50	<50	<50	<50
Zinc	<20	<20	27	26	<20
pH	7.4	7.7	NA	7.4	7.4
Conductivity	700	700	NA	680	700

B: Compound Found in Blank

R: Unuseable data

NA: Not Analyzed

Note: All other USEPA Target Compound List (TCL) Volatile Organics, Semi-Volatile Organics and PCB/Pesticides were Non-Detectable

possibly account for this magnitude of increase in surface water concentrations. It is possible that this increase could be from the storm drain. Apparently this drain is difficult to see due to vegetative growth and may have been overlooked by the samplers.

The bis(2-ethylhexyl)phthalate which decreased between sampling locations was also found in the blank sample. Bis(2-ethylhexyl) phthalate is a common laboratory/sampling contaminant from samples coming in contact with plastic equipment. However, it was also detected in all of the sediment samples upstream and adjacent to the site. If present, it would most likely have originated from an upstream source.

The November 21, 1991 sampling event involved the collection of surface water samples from three locations; upstream near Transect A, adjacent to the center of the site near Transect C and immediately downstream of the site near Transect D. Each sample was collected from the center of the river channel. River flow on the date of the sampling averaged 1,270 ft³/s. Groundwater from the Auto Ion site was discharging into the river as shown on Figure 1-6. The results of the sampling event are contained in Table 1-13. Only silver was shown to increase between the upstream and downstream sampling locations. Silver increased just above the detection limit in the water sample collected near Transect C, out from the center of the site. Silver also increased in the October 1987 sampling event. However, since the increase is so near the detection limit it is questionable as to whether the increase actually occurred. In any event, modeling data presented in Section 1.2.6.2.3 of this risk assessment demonstrates that the groundwater from the Auto Ion site could not possibly account for this increase.

All other metals with detectable concentrations decreased between the upstream and downstream sampling locations; calcium decreased 2%, magnesium decreased 2%, manganese decreased 6%, sodium decreased 4% and zinc decreased 37%.

In general concentrations of constituents decreased between the two sampling events, except for calcium, sodium and zinc which all increased. The apparent scouring and suspension of sediments below Mill Street Bridge was not observed during the second sampling event as evidenced by the low concentrations of constituents in the downstream samples.

AUTO ION SITE
KALAMAZOO, MICHIGAN

TABLE 1-13

SURFACE WATER SAMPLE RESULTS ($\mu\text{g/L}$)
NOVEMBER 1991

	Upstream	Adjacent	Downstream
Aluminum	<200	<200	<200
Antimony	<58	<58	<58
Arsenic	<10	<10	<10
Barium	<200	<200	<200
Beryllium	<1.0	<1.0	<1.0
Cadmium	<3.0	<3.0	<3.0
Calcium	83,500	81,500	81,900
Chromium	<6.0	<6.0	<6.0
Cobalt	<10	<10	<10
Copper	<25	<25	<25
Cyanide	<5.0	<5.0	<5.0
Iron	154*	<100	<100
Lead	<1.0	<1.0	<1.0
Magnesium	23,100	22,900	22,700
Manganese	52	49	49
Mercury	<0.20	<0.20	<0.20
Nickel	<10	<10	<10
Potassium	<5,000	<5,000	<5,000
Selenium	<1.0 W	<1.0 W	<1.0 W
Silver	<10	11	<10
Sodium	19,200	18,600	18,500
Thallium	<1.0	<1.0 W	<1.0
Vanadium	<50	<50	<50
Zinc	49*	34*	31*

*: Duplicate results for this compound not within control limits

W: Estimated Detection Limit

Note: All USEPA Target Compound List (TCL) Volatile Organics and Semi-Volatile Organics were non-detectable.

Summary of Surface Water Sampling

Based on the two surface water sampling events and modeling data presented latter in this table 1-13 baseline risk assessment, current concentrations of groundwater from the Auto Ion site do not appear to be adversely impacting surface water quality. During the two sampling events, surface water appeared to be diluted by a factor of approximately 2% to 5%. During the first sampling event, increased river velocities below Mill Street Bridge appear to have caused increased scouring, resulting in the suspension of sediments which caused water quality parameters to increase at the downstream sampling location.

1.2.6.2.3 Modeling Groundwater Discharge into the Kalamazoo River

A model was developed in accordance with USEPA baseline risk assessment guidance to determine the potential for adverse impacts to surface water from groundwater at the Auto Ion site. The model used is a dilution model suggested by USEPA for use as a screening step to determine the impact of a discharge to surface water. The model is from the USEPA 1988 Superfund Exposure Assessment Manual. USEPA guidance suggest that if this modeling indicates a potential hazard, a more detailed modeling of the discharge to surface water should be undertaken as a next step. This model represents a realistic worst case scenario since it assumes all shallow groundwater contains upperbound 95% confidence limit concentrations per USEPA guidance. The model is shown below:

$$C = \frac{C_e Q_e}{Q_t}$$

Where:

- C = concentration of substance in stream (mass/volume).
- C_e = concentration of substance in effluent(mass/ volume); used concentration in impacted groundwater discharging from site.
- Q_e = effluent flow rate (volume/time); used impacted groundwater discharge rate.
- Q_t = combined effluent and stream flow rate(volume/ time); used combined impacted groundwater discharge rate and river flow.

The following assumptions are implicit in this equation:

- it does not account for background (upstream) concentrations in river;
- mixing of the hazardous substances in the water is instantaneous and complete;
- the hazardous substance is refractive (i.e. all decay or removal processes are disregarded); and,
- stream flow and rate of contaminant release to the stream are constant (i.e. steady-state conditions).

The constituents of concern are nonconservative hazardous substances; the concentrations of these substances would not necessarily remain constant downstream of the mixing zone. Therefore, in accordance with the USEPA 1988 Superfund Exposure Assessment Manual, this equation provides a worst case estimate for the downstream fate of these substances.

Site specific assumptions used in the groundwater discharge model are presented in Table 1-14. In accordance with USEPA risk assessment guidance the 95% upper confidence limit for on-site shallow groundwater concentration was used. The groundwater gradient was determined based on gradients observed during the RI. The hydraulic conductivity used was from measurements made in the RI. The area of impacted groundwater discharge was assumed to occur across the entire length of the site along the river, extending to a depth of eight feet, which is a few feet below the depth of the river. A typical effective porosity value for the site specific aquifer geology was used. Darcy's Law was used to calculate the discharging impacted groundwater flow rate. Upstream surface water concentrations were assumed to be zero, so that the concentration from the impacted groundwater in the river could be examined separately. The upstream surface water quality is examined later as part of the evaluation of the results. The surface water flow used was the 7Q10 obtained from USGS. This is the estimated worst average seven day drought flow which would occur within a ten year period. This is the river drought flow typically used to evaluate worst

**AUTO ION SITE
KALAMAZOO, MICHIGAN**

TABLE 1-14

ASSUMPTIONS USED IN GROUNDWATER DISCHARGE MODEL

Parameters	Assumption	Source
Concentrations of Hazardous Substances in Groundwater Discharge	95% Upper Confidence Limit for On-Site Shallow Groundwater	Baseline Risk Assessment
Groundwater Flow	0.00376 ft ³ /s	Darcy's Law
Hydraulic Conductivity	1.16 x 10 ⁻² cm/s	Remedial Investigation (RI) Field Measurements
Groundwater Gradient	0.0046 ft/ft	Observed Discharge Gradient From Remedial Investigation
Effective Porosity	0.2	Typical Aquifer Value
Area of Groundwater Discharge	2,160 ft ²	Length of site 270' by 8' depth
Surface Water Concentration	-0-	NA
Surface Water Flow	261 ft ³ /s	7010-YSGS(1)

(1) Comstock Park Gage Station 1993-1979

NA: Not Applicable

case conditions for modeling point source impacts on rivers to determine NPDES surface discharge restrictions. The 7Q10 is estimated at 261 ft³/s. The lowest flow ever recorded along this section of the Kalamazoo River was 119 ft³/s.

The resulting surface water concentrations from the model are presented in Tables 1-15 and 1-16. The predicted concentrations range between a factor of 62 (iron) to 100,000 (2,4-dimethylphenol) times below the USEPA contract required detection limits (CRDL). Other than iron, all constituents are over three orders of magnitude lower than the CRDL. Therefore, quantitative assumptions used in the model would have to increase by a factor of at least 62 times before iron could be detected. Other analytes and compounds would require an increase of at least over three orders of magnitude to detect the substances contained in the groundwater discharge in the surface water. A sensitivity analysis of the quantitative parameters used in the model indicates that there are no reasonable assumptions which could be made, which would result in an increase of 62 times the presented results. For example, if the depth of the groundwater discharge area was increased by a factor of four (32 feet deep), the groundwater gradient were increased by a factor of four (0.0150 ft/ft) and the surface water flow were reduced to the lowest recorded flow (119 ft³/s), the resulting concentrations would still only increase by a factor of 35. It should also be noted that, 1) the 95% upper confidence limit concentrations are very conservative since they assume non-detectable concentrations to be equal to their detection limit, 2) the model assumes that the entire site is discharging groundwater at the 95% upper confidence limit concentrations, and 3) the river flow level is lower than flow levels would be expected to be during field sampling events.

Tables 1-17 and 1-18 compare the model results to measured surface water quality at the site and MDNR Water Quality Standard Guidelines. The model results would not increase measured surface water quality results if they were added together, since they are orders of magnitude below measured concentrations. The model results are also over one order of magnitude to several orders of magnitude below the MDNR Surface Water Quality Standard Guidelines. These Michigan Rule 57(2) Guideline Levels are used by the MDNR in making water quality based permit recommendations after a point source is mixed with the receiving stream.

AUTO ION SITE
KALAMAZOO, MICHIGAN

TABLE 1-15

MODELED INORGANIC GROUNDWATER CONCENTRATIONS
IN THE KALAMAZOO RIVER

Organic	Concentration*	CRQL	Factor By Which Concentration Is Below CRQL
Aluminum	0.51	200	390
Arsenic	0.0004	10	25,000
Barium	0.029	200	6,900
Beryllium	0.004	5	1,200
Cadmium	0.0003	5	17,000
Calcium	6.4	5,000	780
Total Chromium	0.01	10	1,000
Hexavalent Chromium	0.0012	10	8,300
Cobalt	0.0017	50	29,000
Copper	0.0054	25	4,600
Cyanide	0.0088	10	1,100
Iron	1.6	100	62
Lead	0.0032	5	1,500
Magnesium	2.0	5,000	2,500
Manganese	0.14	15	110
Mercury	0.000014	0.2	14,000
Nickel	0.081	40	490
Potassium	1.1	5,000	4,500
Sodium	4.2	5,000	1,200
Vanadium	0.0012	50	42,000
Zinc	0.026	20	770

Notes:

CRQL - Contract Required Quantitation Limits (CLP)

* $\mu\text{g/L}$

AUTO ION SITE
KALAMAZOO, MICHIGAN

TABLE 1-16

MODELED ORGANIC GROUNDWATER CONCENTRATIONS
IN THE KALAMAZOO RIVER

Organic	Concentration*	CRQL*	Factor By Which Concentration Is Below CRQL
Chloromethane	0.0002	10	50,000
Vinyl Chloride	0.0004	10	25,000
Methylene Chloride	0.0026	10	3,800
Trans-1,2-Dichloroethene	0.0009	10	11,000
1,2-Dichloroethene	0.0006	10	17,000
1,2-Dichloroethane	0.0002	10	50,000
Chloroform	0.0004	10	25,000
Trichloroethene	0.0024	10	4,200
1,2-Dichlorobenzene	0.0003	10	33,000
2,4-Dimethylphenol	0.0001	10	100,000

CRQL - Contract Required Quantitation Limits (CLP)

* $\mu\text{g/L}$

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**AUTO ION SITE
KALAMAZOO, MICHIGAN**

TABLE 1-17

**INORGANIC SURFACE WATER MODELING
COMPARED TO WATER QUALITY STANDARDS**

(1)

	Groundwater Discharge Model Surface Water Concentrations ($\mu\text{g/L}$)	Range of Surface Water Concentrations Measured in RI ($\mu\text{g/L}$)	MDNR Water Quality Standard Guidelines ($\mu\text{g/L}$)
Aluminum	0.51	<200-220	NA
Arsenic	0.0004	<10	184
Barium	0.029	<200	NA
Beryllium	0.004	<5	NA
Cadmium	0.0003	<5-13	0.70 (2)
Calcium	6.4	72,600-83,500	NA
Total Chromium	0.01	<10-39	85 (2)
Hexavalent Chromium	0.0012	<10	2.0
Cobalt	0.0017	<50	NA
Copper	0.0054	<25-32	21 (2)
Cyanide	0.0088	<10	4
Iron	1.6	<100-530	NA
Lead	0.0032	<5-200	9.7 (2)
Magnesium	2.0	21,800-23,100	NA
Magnanese	0.14	37-58	NA
Mercury	0.000014	<0.2	0.0013 (3)
Nickel	0.081	<40-61	63 (2)
Potassium	1.1	<5,000	NA
Sodium	4.2	15,700-19,200	NA
Vanadium	0.0012	<50	3.73
Zinc	0.026	20-27	89 (2)

(1): 1991 Michigan Rule 57(2) Guidelines for Surface Water Quality After Mixing.

(2): Assumes Hardness of 200 mg/L from MDNR Surface Water Data

(3): Standard is for Methyl Mercury Only.

NA: Not Available

AUTO ION SITE
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TABLE 1-18

ORGANIC SURFACE WATER MODELING RESULTS
COMPARED TO WATER QUALITY STANDARDS

(1)

	Groundwater Discharge Model Surface Water Concentrations ($\mu\text{g/L}$)	Range of Surface Water Concentrations Measured in RI ($\mu\text{g/L}$)	MDNR Water Quality Standard Guidelines ($\mu\text{g/L}$)
Chloromethane	0.0002	<10	NA
Vinyl Chloride	0.0004	<10	3.1
Methylene Chloride	0.0026	<5	59
Trans-1,2-Dichloroethene	0.0009	<5	300
1,2-Dichloroethene	0.0006	<5	NA
1,2-Dichloroethane	0.0002	<5	560
Chloroform	0.0004	<5	43
Trichloroethene	0.0024	<5	94
1,2-Dichlorobenzene	0.0003	<10	7
2,4-Dimethylphenol	0.0001	<10	NA

(1): 1991 Michigan Rule 57(2) Guidelines for Surface Water Quality After Mixing.

NA: Not Available

They are meant to be advisory in nature and may not necessary apply to a given waterway.

On page 54 of USEPA's 1988 Superfund Exposure Assessment Manual, it states that:

If the released substance is found through this estimation procedure [surface water dilution model] to be diluted to concentrations below a predetermined level of concern, and no important exposure points exist within the mixing zone, the fate of the substance in this medium may need no further analysis.

1.2.6.2.4 Fate of Groundwater Constituents in the River

The sediments in the Kalamazoo River at the location of the Auto Ion site are erosional in nature. The sediments are composed of sand and gravel with minor amounts of silt in sporadic locations. This is due to the high average river flow velocities at this location. Residual constituents in the groundwater discharging into the river would be expected to enter the water column. Some of the inorganic constituents may end up in sediments in downstream depositional areas (e.g. impoundments). However, the concentrations entering the water column would be extremely low and could not even be detected. The total mass of residual constituents contained in the impacted groundwater from the Auto Ion site would be very small. The only remaining source of the residuals will be removed in Operable Unit I. The impacted groundwater appears to be limited to an approximately 250' square area of shallow groundwater with low concentrations of residual constituents. The addition of these constituents to the river sediments in downstream depositional areas over an extended period of time would not be expected to be detectable.

1.2.6.2.5 Natural Attenuation of Groundwater Constituents

Based on groundwater flow measurements during the RI, the groundwater is expected to discharge to the river most of the year. The groundwater discharging to the river contains the residual constituents present in the impacted groundwater. With the last source of groundwater contamination from the Auto Ion site being removed in Operable Unit I, the residuals are expected to decrease in the groundwater as they are flushed into the river. This is believed to be the primary process through which natural attenuation will reduce concentrations in the groundwater to levels similar to the surrounding area.

1.2.6.2.6 Evaluation of River Modeling Approach

This human Baseline Risk Assessment used a dilution model approach to evaluate the impact of groundwater discharging to the Kalamazoo River. This is the approach which is recommended by USEPA Risk Assessment Guidance as a screening type methodology. If this approach results in a potential problem, then a more complex numerical model is recommended. Since the dilution model results in concentrations which are several orders of magnitude below the Michigan water quality criteria, a numerical model approach is not necessary. In addition, there is currently insufficient data to accurately model the groundwater discharge to the river using a numerical approach.

The presence of a mixing zone in the river which could have a significant impact to biota from groundwater appears unlikely. A good understanding of this mixing zone is needed to visualize the pertinence of the collected data. The Kalamazoo River has been identified as a relatively fast moving surface water stream in the area of the Auto Ion site. In fact, the river velocity has been measured in the range of 1.1 to 1.4 feet per second, and this reach of the river has been labeled as a scour channel. This scouring action renders a relatively clean river bottom. An important factor to consider when evaluating the mixing zone of groundwater and surface water at this location is the relative velocities of these two water systems. The Kalamazoo River itself is moving at a relatively fast rate of approximately 1.1 to 1.4 feet per second. Groundwater flow velocities are much less, being in the range of 3 feet per month to 40 feet per year. An extremely small layer of groundwater is discharged into the river when the rapidly moving river flow intersects this very slow moving groundwater flow at the relatively clean river bottom interface. Specifically, the river traverses the 250 foot frontage of the Auto Ion site every three to four minutes. During this same three to four minute time frame, the groundwater flow system moves approximately $2-3 \times 10^{-4}$ feet, which equates to approximately 60 to 80 microns. Thus, for each complete passage of the river past the Auto Ion site, the groundwater flow system moves approximately the width of three to four human hairs. This relationship of groundwater flow with respect to river water flow means that any mixing zone that exists at the river interface is vanishingly small. Practically speaking, it is not possible to sample this interface. In addition, the practicality of considering any environmental impact associated with this vanishingly small interface is questionable. Also, as concluded in the March 1993 Sediment Toxicity Evaluation Report, there would not be a

measurable effect on water quality due to the large flow in the river as compared to the groundwater flux to the river. The results of the evaluation also support a similar conclusion that there is no discernible impact on the aquatic macroinvertebrate community of the Kalamazoo River.

Currently there are two known areas (Conrail Yard and Production Painting), in addition to Auto Ion which have documented soil and groundwater contamination. These areas and possibly others may be adversely impacting the Kalamazoo River surface water and/or sediment. Without additional data it is not possible to evaluate the impact of these potential sources on biota in the river. The realistic worst case surface water model scenario does consider impact to aquatic biota by comparing water concentrations to MDNR water quality criteria which is developed to be protective of aquatic life.

1.2.6.2.7 Summary of Impact of Groundwater on the Kalamazoo River

Using an USEPA model in accordance with risk assessment guidance, it was determined that current groundwater concentrations entering the river are too diluted to be detected or adversely impact surface water quality. Surface water sampling confirmed that groundwater from the site was not detectable in surface water.

Sediments where groundwater discharges are erosional in nature and would not be expected to concentrate high levels of constituents from the groundwater. Comparison of the RI sediment analytical data to MDNR sediment data from 1971 indicates a large improvement in sediment quality upstream, adjacent and downstream from the site. Historically, numerous facilities are known to have discharged waste into the river. Some residuals of previous discharges appear to remain in the sediments at generally low concentrations.

As described in the March 1993 Sediment Toxicity Evaluation Report, a program was conducted to collect and analyze sediment samples upstream, downstream, and proximal to the Auto Ion site. The chemical analysis indicated contaminants are present upstream of, adjacent to, and downstream of the site, and that field observations identified nearby industrial activities that may have resulted in, and may still be resulting in releases of contaminants to the river. The

finding of the evaluation were that the potential impact of groundwater at the Auto Ion site to water in the Kalamazoo River would not be a measurable effect on water quality.

1.2.6.3 Baseline Risk Assessment Summary

Although extremely unlikely, if shallow groundwater at the site were used for residential drinking water, it would pose unacceptable health risks. The total chronic non-carcinogenic risk would exceed acceptable health based levels by a factor of 15. The primary chemicals of concern listed in decreasing order of importance are nickel, manganese, barium and cadmium.

The total carcinogenic risk for this exposure scenario is estimated at 1.2×10^{-3} . The primary chemicals of concern listed in decreasing order of importance are arsenic and vinyl chloride.

Before the shallow groundwater could be used as a safe drinking water source it would need to be treated for metals and VOCs; particularly for those analytes and compounds listed above.

However, it is not appropriate to consider this scenario since the probability of using shallow groundwater at the Auto Ion site for drinking water is extremely remote. As indicated in the Auto Ion Remedial Investigation Report prepared by Fred C. Hart Associates, Inc., the City of Kalamazoo has a municipal well field located within one mile of the site. However, this field has not been used for some time due to coliform contamination. There are no known plans by the City to re-activate the field. The closest active city well field is shown on Figure 1-20. Little information is available on the usage of industrial wells in the vicinity of the site. It is believed that all residents and industries in the area are on the municipal water supply. This Baseline Risk Assessment determines that groundwater discharging from this site at current concentrations into the adjacent Kalamazoo River has no significant adverse impact.

1.3 Uncertainties Related to Groundwater Impact

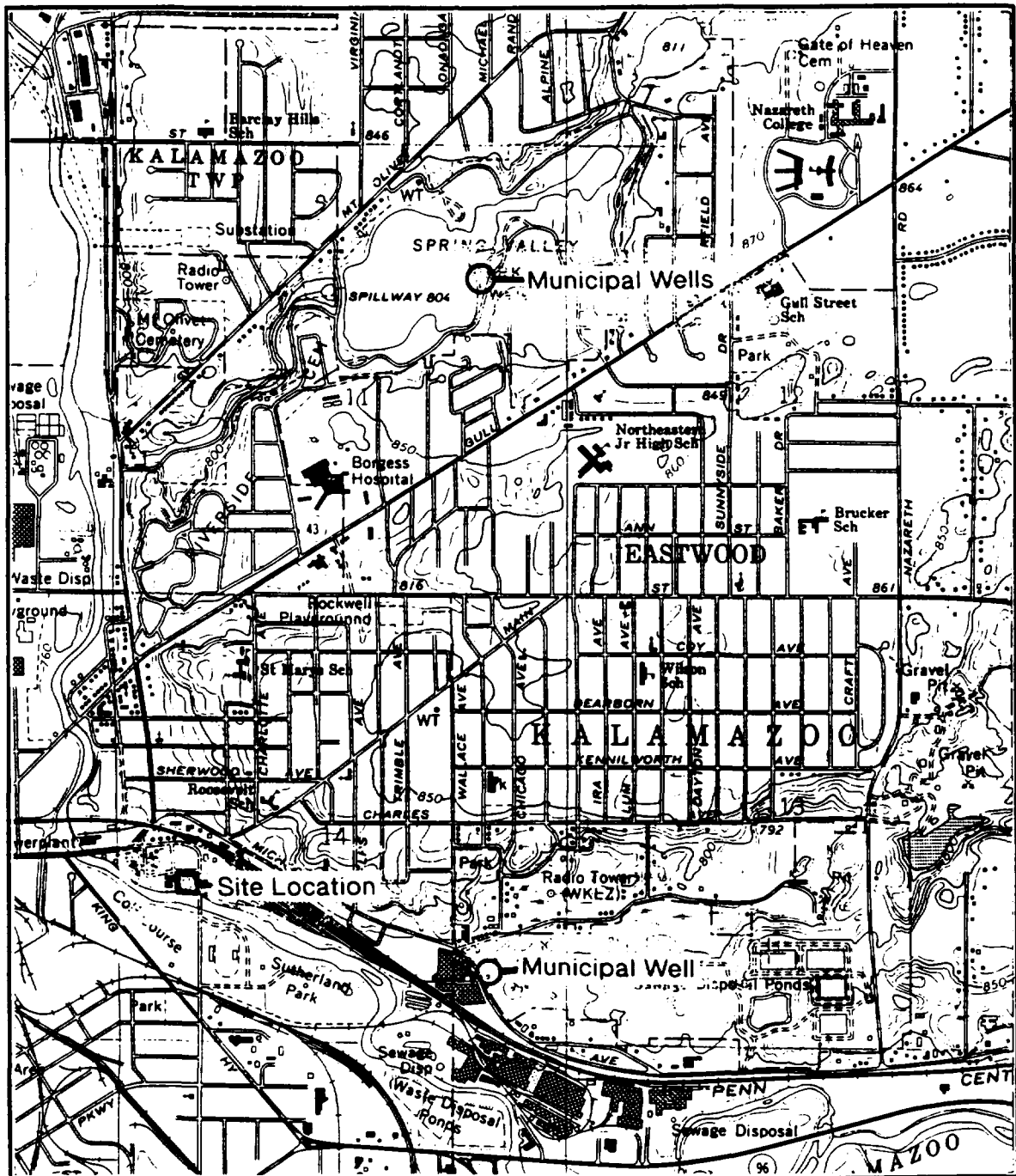
The horizontal extent of impacted groundwater has not yet been defined. The only reliable groundwater data for the VOCs and metals of concern are from the six on-site wells and the one upgradient well. Due to the industrial nature of the area surrounding Auto Ion and documented

contamination of soils and groundwater at adjacent properties (see Appendices A and B), it is difficult to determine how the surrounding area may impact groundwater at the Auto Ion site.

Because all shallow wells on the Auto Ion site have been impacted, it is not possible to determine the horizontal extent of the plume or plumes. The only available off-site groundwater data is from the upgradient well north of the site. This well has been impacted, but to a much smaller degree than the shallow on-site wells. The impact on this background well may be due in part to off-site sources of groundwater contamination and/or the northern edge of the Auto Ion plume when groundwater flow reversals occur at the site. However, at this time the lack of additional data precludes an adequate technical assessment to determine the size of the plume or plumes.

The Production Painting facility is located immediately west of the Auto Ion site. Groundwater level measurements at Auto Ion and field work conducted by Production Painting document that groundwater sometimes flows from the Production Painting site to the Auto Ion site (see Appendix B). Extensive soil sampling at the Auto Ion site has only identified one boring location (MW-3B) where VOCs were found above the water table. Based on an August 15, 1989 report, it appears that Production Painting found VOCs at each of the only two soil sample locations tested, at least one of which is known to be above the water table (see Appendix B). Reportedly, the former owner of the Auto Ion facility made several formal complaints to regulatory agencies concerning the direct discharge of solvents from the Production Painting facility onto the Auto Ion property (see Appendix B). The lack of any additional data on the Production Painting facility precludes an adequate technical evaluation. Although soil and groundwater contamination have been documented at this site, it has not been established, with certainty, whether any contaminants from the Production Painting facility may be migrating onto the Auto Ion site.

Several elevated metals in groundwater at the Auto Ion site appear to be residuals from a water conditioning operation such as for boilers which were used at Auto Ion and in steam locomotives. The metals are most prevalent and concentrated on the eastern side of the site. The Conrail railroad yard is located across the street from the Auto Ion site on the eastern side. Conrail has installed monitoring wells along this side of the site across the street from Auto Ion (see Appendix A). No known metal or VOC data is available for any groundwater or soil samples



U.S. Geological Survey
Kalamazoo Quadrangle
Michigan

MUNICIPAL WELL LOCATION MAP

AUTO ION SITE
KALAMAZOO, MICHIGAN

from the Conrail site. Groundwater elevation data collected at the Auto Ion site indicates that groundwater sometimes moves from the eastern direction of the Conrail site toward the Auto Ion site. Petroleum contamination of groundwater is known to have occurred at the Conrail site (see Appendix A). Locomotive servicing and repair is also known to have occurred on the western portion of the Conrail site immediately across the street from Auto Ion (see Appendix A). At this time, sufficient groundwater data is not available to conduct an adequate technical evaluation of this concern. It has not currently been established, with certainty, whether any contaminants from the Conrail site are migrating onto the Auto Ion site.

The Kalamazoo River, which has been adversely impacted from multiple sources of contamination is hydraulically connected to the Auto Ion site. When river elevations rise above groundwater, river water moves through the sediments and into the site's groundwater. These flow reversals may adversely impact groundwater at the Auto Ion site. However, sufficient groundwater and river data are not available to make an adequate technical assessment.

The upgradient background well has consistently contained only one VOC, tetrachlorethene, during each sampling event. This compound has not been detected in groundwater at the Auto Ion site during any of the sampling events. Therefore, it appears that there may be an upgradient source of tetrachloroethene. Several metals have also been found at elevated levels in this well which may also be due to an upgradient source. However, sufficient groundwater data is not available to conduct an adequate technical evaluation of this concern.

Sodium has been identified in high concentrations well above USEPA health based criteria levels for drinking water, which may be in part due to a background source. Sodium in other groundwaters in the county, including the City of Kalamazoo, is much lower and meets USEPA health based criteria. It appears that the groundwater in the area around the Auto Ion site may be adversely contaminated with sodium, possibly from road salt, the Auto Ion site, and/or other off-site sources, to a level which is not fit for potable use.

Operable Unit I Remedial Actions will eliminate all potential sources of groundwater contamination above acceptable levels from the Auto Ion site. However, if continuing off-site sources of contamination exist and are not identified and controlled, active groundwater

remediation actions at the Auto Ion site may have no end point. Although limited, available evidence indicates a high potential for on-going sources of groundwater contamination at nearby facilities which may be impacting the groundwater at the site.

The implementation of Operable Unit I will eliminate any further source of groundwater contamination from previous operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer.

1.3.1 Summary

Several important factors characterizing groundwater impact at and around the Auto Ion site are uncertain:

- 1) The impact of the Operable Unit I source remediation is expected to significantly improve groundwater quality in a relatively short period of time;
- 2) Background groundwater quality appears to exceeds drinking water health based criteria for sodium which may be due to a regional problem such as road salt;
- 3) The Conrail Yard may be a source of some groundwater contamination at the Auto Ion site;
- 4) The Production Painting facility may be a source of some groundwater contamination at the Auto Ion site;
- 5) Other sources of upgradient groundwater contamination may exist as suggested by the consistent presence of tetrachloroethene in MW-1; and,
- 6) The horizontal extent of impacted groundwater from all sources is unknown.

2.0 IDENTIFICATION OF POTENTIAL ARARs

Pursuant to Section 121(d)(1) of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial actions must attain a degree of cleanup that assures protection of human health and the environment. Remedial actions must also attain legally applicable or relevant and appropriate requirements, criteria, or limitations of federal and state laws and regulations. These applicable or relevant and appropriate requirements are known as ARARs.

This section identifies potential ARARs for Operable Unit II response action alternatives which are evaluated in Section 7.

2.1 Applicable Requirements

Applicable requirements are those standards and requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

For a requirement to be applicable, the remedial action or the circumstances at the site must satisfy all of the jurisdictional prerequisites of that requirement. For example, the Safe Drinking Water Act (SDWA) maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) would apply only to drinking water at the tap, not groundwater in an aquifer. See 55 Federal Register 8742, (Thursday, March 8, 1990).

2.2 Relevant and Appropriate Requirements

Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated

under federal or state law that, although not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well-suited to the particular site. A requirement that is determined to be relevant and appropriate must be complied with to the same degree as if it were applicable. The determination of whether a requirement is relevant and appropriate is based on a site specific evaluation of eight factors. These factors are: 1) the purpose of the requirement and the purpose of the CERCLA action; 2) the medium regulated or affected by the requirement and the substances found at the CERCLA site; 3) the substances regulated by the requirement and the substances found at the CERCLA site; 4) the actions or activities regulated by the requirement and the remedial action contemplated at the CERCLA site; 5) any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site; 6) the type of place regulated and the type of place affected by the release or CERCLA action; 7) the type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated by the CERCLA action; and, 8) any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource at the CERCLA site. The determination of whether a requirement is relevant and appropriate is based on an overall evaluation of these factors using professional judgement. It is possible for only part of a requirement to be considered relevant and appropriate, the rest being dismissed if judged not to be relevant and appropriate in a given case. It is also possible for a requirement to be considered relevant and appropriate for only part of the site and/or for only certain chemicals at a site.

2.3 Other Criteria or Guidelines to be Considered

Remedial actions must also take into account additional criteria that are "to be considered" (TBCs) if ARARs do not address a particular situation or action. TBCs are unenforceable criteria, advisories or guidance issued by the federal or state agencies. They are not legally binding and do not have the status of ARARs. However, they are generally considered along with the ARARs in determining the level of cleanup required for protection of health and the environment. Examples of TBC criteria are the reference doses and potency factors for ingestion of noncarcinogenic and

carcinogenic compounds used in the Baseline Risk Assessment.

2.4 Potential ARARs

The ARARs have been placed in three specific categories:

- Chemical-specific
- Location-specific
- Action-specific

Chemical-specific ARARs include those laws and requirements that regulate the release of hazardous substances or pollutants to the environment. They generally place limits on concentrations of specific chemicals that can be released to or be present in the environment.

Location-specific ARARs relate to the geographical position of the site. They, for example, include regulations pertaining to activities within wetlands, flood plains, and historic sites. They may limit the type of remedial action that can be implemented, or place added constraints on the cleanup process.

Action-specific ARARs define acceptable treatment and disposal procedures for hazardous substances. They are generally technology-based regulations, including performance and design standards, identified by the types of remedial action under consideration.

2.5 Chemical-Specific ARARs

Several federal and state laws have regulations which set chemical concentration requirements in water. They are:

- Federal Safe Drinking Water Act (SDWA)
- Michigan Safe Drinking Water Act (MSDWA)

- Michigan Environmental Response Act (Act 307)
- Federal Resource Conservation and Recovery Act (RCRA)
- Michigan Hazardous Waste Management Act (Act 64)
- Federal Clean Water Act (CWA)
- Michigan Water Resources Commission Act of 1929 as amended (WRC)

Chemical-specific ARARs often play an important role in determining the remedial action objectives for a site and have been used to help generate the list of remedial action alternatives. Therefore, this section discusses each of the potential chemical-specific ARARs in detail as to how they apply at the Auto Ion site. Table 2-1 summarizes this section and identifies which requirements are chemical-specific ARARs for the Auto Ion site.

2.5.1 SDWA and MSDWA

The SDWA and MSDWA are not applicable to groundwater at the Auto Ion site since it is not used as a drinking water source. The regulations for these laws specify that these concentration limits be obtained at the point of distribution of drinking water.

The MSDWA does not include any chemical-specific requirements which are more stringent than the SDWA for the compounds and analytes of concern at the Auto Ion site. Therefore, the MSDWA will no longer be considered as a potential ARAR.

These limits are also not relevant or appropriate requirements. CERCLA recognizes that drinking water limits are not relevant or appropriate limits for groundwater remediation at all sites, but rather should be evaluated based on the site specific "circumstances" of the release. Under Section 121(d)(2)(A) CERCLA states:

...remedial action shall require a level or standard of control which at least attains Maximum Contaminant Level Goals established under the Safe Drinking Water Act and water quality criteria established under Section 304 or 303 of the Clean Water Act, where such goals or criteria are relevant and appropriate under the

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TABLE 2-1

SUMMARY OF POTENTIAL CHEMICAL-SPECIFIC ARARs

REGULATION	CHEMICAL-SPECIFIC REQUIREMENTS	CITATION	POTENTIAL ARAR
Federal Safe Drinking Water Act (SDWA)	MCLs and MCLGs	40 CFR 141.11-14.16 & 141.50-141.51	⁽¹⁾ No
Michigan Safe Drinking Water Act (MSDWA)	MCLs and MCLGs	MI ACT 325 SEC. 325.1006	⁽²⁾ No
Michigan Environmental Response Act (Act 307)	Type B Criteria and Type C Site Specific Risk Assessment	MI ACT 307 R717	Yes
Federal Resource Conservation and Recovery Act (RCRA)	MCLs or ACLs	RCRA 40 CFR Sec. 3004(p)	⁽³⁾ No
Michigan Hazardous Waste Management Act (Act 64)	MCLs or ACLs	MI ACT 64 R299.4612	Yes
Federal Clean Water Act (CWA)	Water Quality Criteria	51 Federal Register 43665	⁽⁴⁾ No
Michigan Water Resources Commission Act (WRC)	Water Quality Standards	MI ACT 245 R 323.1041-1116	Yes

(1) TBC

(2) Same as Federal SDWA Requirements

(3) Less Stringent than Michigan Act 64 Requirements

(4) Less Stringent than Michigan WQS

circumstances of the release or threatened release. See CERCLA Section 121(d)(2)(A).

In the Preamble to the National Contingency Plan (NCP), USEPA indicates that although groundwater should generally be cleaned up to SDWA limits, cleanup goals for response actions to groundwater remediation are dependent upon site specific conditions. Under the groundwater policy section of the Preamble to the NCP it states that:

At every site, EPA must decide the appropriate level of remediation necessary to protect human health and the environment and determine what requirements are ARARs based on the beneficial use of the groundwater and specific conditions of the site. See 55 Federal Register 8733 (Thursday, March 8, 1990).

Although the shallow groundwater at the Auto Ion site could be considered a potential drinking water supply source, the potential for this to occur is extremely remote. Adequate city water is supplied to the site and surrounding neighborhood and the shallow groundwater leaving the site is discharged to surface water. Institutional controls are currently in place to prevent the use of this water (see Section 1.2.6.1). The Preamble to the NCP provides examples of this type of site specific condition at CERCLA sites. Under the groundwater policy section, in a discussion of the appropriateness of natural attenuation, USEPA states that:

Natural attenuation is generally recommended only when active restoration is not practicable, cost-effective or warranted because of site specific conditions (e.g. Class III groundwater or groundwater which is unlikely to be used in the foreseeable future and therefore can be remediated over an extended period of time) or... See 55 Federal Register 8734 (Thursday, March 8, 1990).

Under Section 300.430(d) of the Preamble to the NCP, USEPA indicates that the likelihood of future exposure should be reasonable and considered when estimating future risks to determine remedial action objectives, it states:

An assumption of future ... land use may not be justifiable if the probability that the site will support ...[that] use in the future is small. See 55 Federal Register 8710 (Thursday, March 8, 1990). And,

EPA is clarifying its policy of making exposure assumptions that result in an overall exposure estimate that is conservative but within a realistic range of exposure. Under this policy, EPA defines "reasonable maximum" such that only potential exposures that are likely to occur will be included in the assessment of exposures. See 55 Federal Register 8710 (Thursday, March 8, 1990).

Since the likelihood of use of the shallow groundwater at the site is extremely remote, drinking water requirements are not relevant or appropriate.

Each of the factors used to determine relevant and appropriate requirements are listed below:

- 1) The purpose of the requirement and the purpose of the CERCLA action - The purpose of the requirement is to protect public health from drinking water. The purpose of the CERCLA action is to protect public health and the environment. The groundwater at this site is not used for drinking water and the possibility of future use is extremely remote.
- 2) The medium regulated or affected by the requirement and the medium contaminated or affected at the CERCLA site - Both mediums are water.
- 3) The substances regulated by the requirement and the substances found at the CERCLA site - Both substances are generally the same.
- 4) The actions or activities regulated by the requirement and the remedial action contemplated at the CERCLA site - The requirements regulate drinking water, the remedial action does not contemplate use of shallow groundwater for drinking water under any reasonable scenario.

- 5) Any variances, waivers, or exemptions of the requirement and their availability for the circumstances at the CERCLA site - Section 121(d)(2)(B)(ii) of CERCLA specifies an exemption to SDWA requirements in the form of alternate concentration limits (ACLs) under the exact same conditions as exist at the Auto Ion site; the groundwater from the site discharges to an immediately adjacent surface water body with no measurable impacts.
- 6) The type of place regulated and the type of place affected by the release or CERCLA action - The type of places regulated are public drinking water systems, groundwater at the site is not used for drinking water and the possibility of future use is extremely remote.
- 7) The type and size of structure or facility regulated and the type and size of structure or facility affected by the release or contemplated remedial action - Public drinking water systems are generally regulated if they supply more than approximately 25 people. The groundwater at the site is not used for drinking water. Groundwater, from the approximately two acre site, discharges into the adjacent river.
- 8) Any consideration of use or potential use of affected resources in the requirement and the use or potential use of the affected resource at the CERCLA site - The groundwater at the site is not used for drinking water and the possibility of future use is extremely remote. See 55 Federal Register 8744 (Thursday, March 8, 1990).

Although the drinking water requirements of the SDWA and MSDWA are not ARARs, they will be evaluated as TBCs.

The MDNR does not agree with this position and believes that the SDWA is an ARAR.

2.5.2 Act 307

Rule 299.5107 states that Act 307 is applicable to all known sites of environmental contamination. Therefore, Act 307 is applicable to Operable Unit II of Auto Ion and is an ARAR.

Act 307 includes three types of chemical cleanup criteria; Type A, Type B and Type C. A Type A cleanup involves remediating to background concentrations or detection levels, whichever is greater. A Type B cleanup for groundwater involves remediating to the lowest of the following:

- a risk level of 1×10^{-6} for a carcinogen using a standardized exposure scenario;
- a safe human life cycle concentration using a standardized exposure scenario for non-carcinogens, non-genotoxic teratogens and non-germ line mutagens;
- secondary maximum contaminant level; or,
- if one or more hazardous substances imparts adverse aesthetic characteristics to the groundwater, the taste and odor threshold concentrations of these substances.

A Type C cleanup involves developing remedial concentrations based upon a site specific risk assessment. This risk assessment must demonstrate that the cleanup levels are appropriate based on the following considerations:

- reasonably foreseeable uses of site and natural resources;
- potential exposure of human and natural resource targets;
- environmental media affected;
- site geology, hydrology, soils, hydrogeology and other physical settings as appropriate;

- background chemical concentrations;
- current and reasonably foreseeable natural resource use;
- potential chemical migration pathways;
- amount, concentration, form, mobility, persistence, bioaccumulative properties, environmental fate and other relevant characteristics of hazardous substances present;
- the extent hazardous substances have migrated and are expected to migrate from the area of release;
- the impact of future migration of the hazardous substances;
- current or potential impact to food chain contamination;
- climate;
- technical feasibility and cost-effectiveness of remedial action alternatives, including alternatives which comply with Type B criteria;
- the evaluation of remedial action alternatives pertaining to:
 - the effectiveness of alternatives in protecting the public health, safety, and welfare and the environment and natural resources;
 - the long-term uncertainties associated with the proposed remedial action;

- the goals, objectives and requirements of the Michigan Solid Waste Management Act;
- the persistence, toxicity, mobility and propensity to bioaccumulate of the hazardous substances;
- the short and long-term potential for adverse health effects from human exposure;
- costs of remedial action, including operation and maintenance;
- reliability of the alternatives;
- the potential for future remedial action costs if an alternative fails;
- the potential threat to human health, safety, and welfare and the environment and natural resources associated with excavation, transportation and redisposal or containment;
- the ability to monitor remedial performance;
- the public's perspective about the extent to which the proposed plan effectively addresses criteria specified in these rules;
- a preference for remedial actions that permanently and significantly reduce the volume, toxicity or mobility of hazardous substances; and,
- a preference for treatment alternatives over off-site transport and disposal alternatives without treatment.
- the uncertainties of the risk assessment;

- the ability to monitor remedial performance;
- consistency with the Great Lakes water quality agreement as amended in 1987 and the Great Lakes toxic control agreement of 1986 for remedial actions which impact the Great Lakes; and,
- other factors appropriate to the site.

Additional requirements are applicable for remedial actions involving on-site containment. The Type C requirements identified above, except for the sites impacting the Great Lakes and/or involving on-site containment are all generally incorporated in the CERCLA Baseline Risk Assessment and FS.

For compounds or analytes whose cleanup criteria are below the method detection limit (MDL), the MDL or the practical quantification limit (PQL) are generally used as the cleanup criteria. Although the MDL is preferred by the 307 rules, the PQL is often more realistic since the MDL can not always be obtained.

The remedial response activity can include one or more of the Type A, Type B and Type C criteria. It is acceptable to use more than one type of criteria (e.g., Type B and Type C) for different chemicals and/or portions of a site.

Remedial action alternatives developed in this FS will include at least one alternative that is potentially capable of achieving a Type B cleanup as specified in the remedial action objectives (see Section 3.2 for a more detailed discussion). Type C alternatives will also be included.

2.5.3 RCRA and Act 64

RCRA and Act 64 are not applicable to groundwater at this site since the site was not a RCRA transport, storage or disposal (TSD) facility. The regulations involving groundwater

concentration limits under these laws only apply to TSD facilities which receive hazardous waste. Auto Ion had ceased operations prior to the implementation of these laws.

Michigan Act 64 is more stringent than RCRA. Therefore, Act 64 will be considered the potential chemical specific ARAR in lieu of RCRA at this site.

Act 64 groundwater protection standards are relevant and appropriate to groundwater at the Auto Ion site and are ARARs. These standards apply to the release of hazardous waste into groundwater. Maximum contaminant levels (MCLs) are provided for some of the compounds and analytes of concern at the Auto Ion site. However, Act 64 provides for ACLs at sites like Auto Ion where the groundwater is not used as a drinking water source and discharges to adjacent surface waters with no measurable adverse impact.

2.5.4 CWA and WRC

The CWA specifies chemical criteria levels to be considered when determining the impact of contaminants on surface water use. Michigan's WRC adopts the CWA's water quality criteria in determining acceptable surface water concentrations. The WRC rules are at least as stringent as the CWA requirements, therefore, only Michigan's WRC will be considered further.

Groundwater containing pollutants from the Auto Ion site discharges to the Kalamazoo River, therefore, Michigan's WRC Water Quality Standards are applicable and are a potential ARAR.

The MDNR disagrees with the way this ARAR is applied in this FS. MDNR's position is that this ARAR does not allow for any mixing zone where groundwater enters surface water. However, this disagreement may be largely academic, the presence of a mixing zone in the river which could have a significant impact to biota from mixed groundwater appears unlikely.

The Kalamazoo River has been identified as a relatively fast moving surface water stream in the area of the Auto Ion site. In fact, the river velocity has been measured in the range of 1.1 to 1.4 feet per second, and this reach of the river has been labeled as a scour channel. This scouring action renders a relatively clean river bottom. An important factor to consider when evaluating the mixing zone of groundwater and surface water at this location is the relative velocities of these two water systems. The Kalamazoo River itself is moving at a relatively fast rate of approximately 1.1 to 1.4 feet per second. Groundwater flow velocities are much less, being in the range of 3 feet per month to 40 feet per year. An extremely small layer of groundwater is discharged into the river when the rapidly moving river flow intersects this very slow moving groundwater flow at the relatively clean river bottom interface. Specifically, the river traverses the 250 foot frontage of the Auto Ion site every three to four minutes. During this same three to four minute time frame, the groundwater flow system moves approximately $2-3 \times 10^{-4}$ feet, which equates to approximately 60 to 80 microns. Thus, for each complete passage of the river past the Auto Ion site, the groundwater flow system moves approximately the width of three to four human hairs. This relationship of groundwater flow with respect to river water flow means that any mixing zone that exists at the river interface is vanishingly small. Practically speaking, it is not possible to sample this interface. In addition, the practicality of considering any environmental impact associated with this vanishingly small interface is questionable.

2.6 Location-Specific ARARs

Location-specific ARARs are requirements which relate to the area in which the site is located. These ARARs may limit the nature of remedial actions or invoke special requirements to preserve or protect aspects of the environment and/or resources of the area that may be threatened or damaged by remedial actions undertaken at a site.

Several federal and state laws have regulations that could be potential location-specific ARARs. These ARARs are identified and a determination is made as to whether they may apply at the Auto Ion site. Potential Federal location-specific ARARs are presented in Table 2-2. Potential Michigan location-specific ARARs are presented in Table 2-3.

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TABLE 2-2

POTENTIAL FEDERAL LOCATION-SPECIFIC ARARS

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Affects any district, site, building structure, or object listed in or eligible for inclusion in the National Register;	Requires Federal agencies to take into account the effect of any Federally-assisted undertaking or licensing on any district, site, building, structure or object that is included in or eligible for inclusion in the National Register of Historic Places;	National Historic Preservation Act	16 U.S.C. 470 40 CFR 6.301(b)	No
Any floodplain;	Requires Federal agencies to evaluate the potential effects of actions they may take in a floodplain to avoid, to the maximum extent possible, the adverse impacts associated with direct and indirect development of a floodplain;	Administrative Order on Floodplain Management	Executive Order No. 11,988 40 CFR 6.302(b) and Appendix A	Yes
Affects any historic, prehistoric, and archeological data;	Establishes procedures to provide for preservation of historical and archeological data which might be destroyed through alteration of terrain as a result of a Federal construction project or a Federally licensed activity or program;	Archeological and Historic Preservation Act	16 U.S.C. 469 40 CFR 6.301(c)	No
Affects any national natural landmarks;	Requires Federal agencies to consider the existence and location of landmarks using information provided by the National Park Service pursuant to 36 CFR 62.6(d) to avoid undesirable impacts on such landmarks.	Historical Sites, Buildings and Antiquities Act	16 U.S.C. 461-467 40 CFR 6.301(a)	No

TABLE 2-2 Continued...

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Affects any natural stream or body of water;	Requires consultation when Federal department or agency proposes or authorizes any modification of any stream or other water body and adequate provision for protection of fish and wildlife resources;	Fish and Wildlife Coordination Act	16 U.S.C. 661-666 40 CFR 6.302 (g)	No
Affects any threatened or endangered species or critical habitats	Requires that Federal agencies insure that any action authorized or funded by the agency is not likely to jeopardize the continued existence of any threatened or endangered species or destroy or adversely modify critical habitat;	Endangered and Threatened Wildlife and Plants Act	16 U.S.C. 1531-1543 50 CFR 17, 402	No
Affects coastal zones	Prohibits Federal agencies from undertaking any activity in or affecting a State's coastal zone that is not consistent to the maximum extent practicable with a State's approved coastal zone management program;	Coastal Zone Management Act	16 U.S.C. 1451-1464	No
Affects wild and scenic rivers or study rivers	Applicable to water resource development projects affecting wild, scenic, or recreational rivers within or studies for inclusion in the National Wild and Scenic Rivers System;	Wild and Scenic Rivers Act	16 U.S.C. 1271-1287 40 CFR 6.302(e) 36 CFR 297	No

TABLE 2-2 Continued...

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Affects all waterways within the United States;	The objective of the Clean Water Act is to restore & maintain the chemical, physical & biological integrity of the nation's waters through the following goals: 1) The discharge of pollutants into the navigable waters will be eliminated by 1985; 2) an interim goal of water quality which provides for the protection & propagation of fish, shellfish & wildlife and provides for recreation in and on the water be achieved by 7-1-1983; 3) the discharge of toxic pollutants in toxic amounts shall be prohibited;	Clean Water Act	33 U.S.C. 1251-1376	Yes
Affects any navigable waterway or tributary within the United States;	Requires permit for structures or work in or affecting navigable waters;	Rivers and Harbor Act of 1899	33 U.S.C. 401-413	No
Wetlands	Requires Federal agencies to avoid, to the extent possible, the adverse impacts associated with the destruction or loss of wetlands and to avoid support of new construction in wetlands if a practicable alternative exists;	Executive Order on Protection of Wetlands	Executive Order No. 11,990 40 CFR 6.302 (a) and Appendix A	No

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TABLE 2-3

POTENTIAL MICHIGAN LOCATION-SPECIFIC ARARS

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
All the waters of the Great Lakes within the boundaries of the state;	Dredging or placing spoil or other materials on bottomland of any of the Great Lakes or associated waterway within state boundaries	Great Lakes Submerged Lands Act	Act 247; Public Acts of 1955, as amended; MCL 322.703	No
Within 61 meters of a fault which had its displacement in Holocene time;	The location of active portions of new treatment, storage or disposal facilities, or expansions enlargements, or alterations of existing facilities;	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	No
In a floodway designated by Act 245	The location of active portions of new treatment, storage, or disposal facilities, or expansions, enlargements, or alterations of existing facilities;	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	Yes
In a coastal high-risk area designated under the Shorelands Protection and Management Act;	The location of active portions of new treatment, storage, or disposal facilities, or expansions, enlargements, or alterations of existing facilities;	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	No
Over a sole-source aquifer or the recharge zone of a sole source aquifer	The location of active portions of new treatment, storage, or disposal facilities, or expansions, enlargements, or alterations of existing facilities;	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	No

TABLE 2-3 Continued...

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Within that isolation distance from public water supplies specified by Act 399	The location of active portions of new treatment, storage, or disposal facilities, or expansions, enlargements, or alterations of existing facilities;	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	No
In a wetland	The location of active portions of new treatment, storage, or disposal facilities, or expansions, enlargements, or alterations of existing facilities;	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	No
At least 150 meters from adjacent commercial, residential, or recreational property lines	The location of an active portion of a new landfill	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	No
At least 60 meters from adjacent commercial, residential, or recreational property lines	The location of hazardous waste treatment, storage, or disposal facilities other than landfills	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	Yes
Areas with less than 6 meters of soil with a maximum permeability greater than 1.0 e-6 cm/s at all points below and lateral to the landfill, surface impoundment or waste pile	The location of landfills, surface impoundments and waste piles	Hazardous Waste Management Act General Rules – Part 6 Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities;	Act 64, Public Acts of 1979, as amended R299.9603	No
Tunnels, process equipment, shaft or enclosed space	Entry into a tunnel, process equipment, shaft or enclosed space	Michigan Occupational Safety and Health Act Occupational Health Standards for General Industry	Act 154, Public Acts of 1974 Rule 3301	No

TABLE 2-3 Continued...

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Confined spaces	Entry into a confined space	Michigan Occupational Safety and Health Act Construction Safety Standards	Act 154, Public Acts of 1974 R408.40120	No
Confined spaces	Entry into a confined space	Michigan Occupational Safety and Health Act General Industry Standards	Act 154, Public Acts of 1974 R408.10016	No
100 ft. from the river's edge	Prohibition or limitation of cutting trees or other vegetation	Natural River Act of 1970	Act 231, Public Acts of 1970 MCL 281.770	Yes
300 ft. from the river's edge	Prohibition or limitation of mining and drilling for oil and gas	Natural River Act of 1970	Act 231, Public Acts of 1970 MCL 281.770	No
400 ft. from the river's edge	Control the use of the lands	Natural River Act of 1970	Act 231, Public Acts of 1970 MCL 281.770	Yes
The land, water, and land beneath the water which is in close proximity to the shoreline of a Great Lake or a connecting waterway (shoreland)	Dredging, filling, grading, or other alterations of the soil; Alteration of natural drainage, but not including the reasonable care and maintenance of established drainage improvement works; Alteration of vegetation utilized by fish and wildlife, or both, for the uses covered in subrules (1) and (2) of this rule; Placement of permanent structures;	Shorelands Protection and Management Act of 1970	Act 245, Public Acts of 1970 R281.24	Yes

TABLE 2-3 Continued...

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Any area which is within the 100 year floodplain of a Great Lake or a connecting waterway (flood risk area)	Dredging, filling, grading, or other alterations of the soil; Alteration of natural drainage, but not including the reasonable care and maintenance of established drainage improvement works; Alteration of vegetation utilized by fish and wildlife, or both, for the uses covered in subrules (1) and (2) of this rules; Placement of permanent structures;	Shorelands Protection and Management Act of 1970	Act 245, Public Acts of 1970 R281.24	Yes
Lands within 500 feet of a lake or stream of this state	The location of transportation facilities, industrial or commercial development, utilities, oil, gas, and mineral wells, water impoundments and waterway construction;	Soil Erosion and Sedimentation Control Act	Act 347, Public Acts of 1972 R323.1704	Yes
Michigan counties having a population density of less than 50 persons per square mile based on 1970 census data	The location of Type II sanitary landfills	Solid Waste Management Act	Act 641, Public Acts of 1978 R299.4307	No
Within a standard metropolitan statistical area	The location of Type II sanitary landfills	Solid Waste Management Act	Act 641, Public Acts of 1978 R299.4307	No
Within 100 feet of adjacent property lines, road rights-of-way or lakes and perennial streams	The location of Type II sanitary landfills	Solid Waste Management Act	Act 641, Public Acts of 1978 R299.4307	No
Within 300 feet of domiciles in existence at time of construction	The location of Type II sanitary landfills	Solid Waste Management Act	Act 641, Public Acts of 1978 R299.4307	No

TABLE 2-3 Continued...

REGULATED LOCATION	REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Wetlands	Deposition or permitting the placing of fill material in a wetland; dredging, removing or permitting the removal of soil or minerals from a wetland; constructing, operating, or maintaining any use or development in a wetland; and draining surface water from a wetland;	Goemaire-Anderson Wetland Protection Act	Act 203, Public Acts of 1979 MCL 281.705	No
Within 50 feet from the shore or bank of any lake or stream	Storage of salt	Water Resources Commission Act Part 5 - Spillage of Oil and Polluting Materials	Act 245, Public Acts of 1929 R323.1157	No
Floodplains (that area of land adjoining a river or stream which will be inundated by a 100-year flood)	Occupying, filling, or grading lands in a floodplain, streambed, or channel of a stream	Water Resources Commission Act Part 13 - Floodplains and Floodways	Act 245, Public Acts of 1929 R323.1313	Yes
Floodplains (the channel of a river or stream and those portions of the floodplain adjoining the channel which are reasonably required to carry and discharge a 100-year flood)	Occupying, filling, or grading lands in a floodplain, streambed, or channel of a stream	Water Resources Commission Act Part 13 - Floodplains and Floodways	Act 245, Public Acts of 1929 R323.1313	Yes
	Provides for the conservation, management, enhancement and protection of fish, plant life, and wildlife species endangered or threatened with extinction.	Endangered Species Act	MI Act 203	No
	This act creates and regulates wilderness, wild, and natural areas.	Wilderness and Natural Areas Act	MI Act 241	No
Listed Site	Listed site of environmental contamination.	Environmental Response Act	MI Act 307	Yes

Although not listed in Table 2-2 or 2-3, the MDNR has commented that the Michigan Water Resources Commission Part 22 Rules, the Great Lakes Water Quality Agreement of 1978 (as amended), and the Great Lakes Toxic Substance Control Agreement of 1986 are location-specific ARARs at this site. However, the Part 22 Rules are not applicable at the site because they only regulate the discharge of contaminants and/or materials into, not from the groundwater. Operable Unit I is addressing the control of discharge of source contaminants to the groundwater at the site. Operable Unit II is only concerned with remediation of groundwater which has already been impacted. Consequently, the Part 22 Rules are neither applicable or relevant and appropriate with respect to Operable Unit II.

As for the Great Lakes Water Quality Agreement of 1978 and the Great Lakes Toxic Substance Control Agreement of 1986, even assuming that the general scope of these Agreements may extend to the site, they have not been enacted by any state or federal legislature, nor have they been codified in any state or federal statutory code. Rather, the Agreements appear to provide general philosophical and policy guidance rather than enforceable cleanup standards, or other substantive requirements, criteria or limitations. As such, neither Agreement meets the definition of "applicable requirements" or "relevant and appropriate requirements", as those terms are defined in 40 CFR §300.5 and the 1990 NCP.

2.6.1 National Historic Preservation Act

Requires action to take into account properties included in or eligible for the National Register of Historical Places and to minimize harm to National Historic Landmarks. This requirement is not an ARAR as no registered historic places or landmarks are on-site or nearby.

2.6.2 Archaeological and Historic Preservation Act

Provides for preservation of historical and archaeological data which might be destroyed during a federally sponsored project. This requirement is not an ARAR because no known historical or archaeological material is present on the site or will be impacted.

2.6.3 Historical Sites, Buildings and Antiquities Act

Requires federal agencies to consider and locate any landmarks as defined by the National Park Service. This requirement is not an ARAR as no landmarks are on-site or nearby.

2.6.4 Fish and Wildlife Coordination Act

Requires action to protect fish and wildlife from any modification of streams or areas affecting streams. This requirement is not an ARAR as no remedial activities adversely affecting the Kalamazoo River.

2.6.5 Endangered and Threatened Wildlife and Plants Act

Requires action to insure no activity under taken by a federal agency jeopardizes the continued existence of listed endangered or threatened species or modification of their habitat. This requirement is not an ARAR to the Auto Ion site as no endangered or threatened species exist on-site or nearby.

2.6.6 Coastal Zone Management Act

Prohibits Federal agencies from affecting land or water uses in coastal zone. This requirement is not an ARAR as the Auto Ion site is not located within a coastal zone.

2.6.7 Wild and Scenic Rivers Act

Requires action to avoid affecting designated or studies for inclusion of wild or scenic rivers. This requirement is not an ARAR as the Kalamazoo River is not a wild or scenic river.

2.6.8 Rivers and Harbor Act of 1899

Requires permit for structures or work in or affecting navigable waters. This requirement is not an ARAR as no remedial activities are planned in or affecting the Kalamazoo River.

2.6.9 Executive Order on Protection of Wetlands

Executive Order 1990 requires Federal agencies to avoid adverse impacts associated with the destruction or loss of wetlands. This requirement is not an ARAR since no impacts to any wetlands are anticipated.

2.6.10 Great Lakes Submerged Lands Act

Regulates dredging and placement of spoil on the bottom of the Great Lakes. This requirement is not an ARAR as no planned remedial activities will affect the Great Lakes.

2.6.11 Hazardous Waste Management Act General Rules- Part 6 Owners and Operators of Hazardous Waste Treatment, Storage and Disposal Facilities

Regulates location of active portions of new facilities, and expansions or alterations of existing facilities:

- 1) Placement within 61 meters of a fault which has had displacement in Holocene time. This requirement is not an ARAR as no Holocene of latter fault is on the Auto Ion site.
- 2) In a Coastal high-risk area. This requirement is not an ARAR as the site is not in a coastal area.

- 3) Over a sole-source aquifer or the recharge zone of a sole source aquifer. This requirement is not an ARAR as the site is not over a sole-source aquifer.
- 4) Within that isolation distance from public water supplies specified by Act 399. This requirement is not an ARAR as the site is not the specified distance.
- 5) In a wetland. This requirement is not an ARAR as the site is not in a wetland.
- 6) Location of new landfill at least 150 meters from adjacent commercial, residential or recreational property lines. This requirement is not an ARAR as no new landfill is planned.

2.6.12 Michigan Occupational Safety and Health Act-Occupational Health Standards for General Industry

Entry into confined spaces. This requirement is not an ARAR as no confined entries are planned as part of the planned remedial activities.

2.6.13 Michigan Occupational Safety and Health Act -Construction Safety Standards

Entry into confined spaces. This requirement is not an ARAR as no confined entries are planned as part of the planned remedial activities.

2.6.14 Michigan Occupational Safety and Health Act -General Industry Standards

Entry into confined spaces. This requirement is not an ARAR as no confined entries are planned as part of the planned remedial activities.

2.6.15 Natural River Act of 1970

Prohibition or limitation of mining and drilling for oil and gas. This requirement is not an ARAR as no mining or drilling for oil and gas is planned.

2.6.16 Solid Waste Management Act

- 1) Regulates location of Type II sanitary landfills with regard to population density of counties. This requirement is not an ARAR as no Type II sanitary landfill is planned as part of the remedial action.
- 2) Regulates location of Type II sanitary landfills with regard to metropolitan areas. This requirement is not an ARAR as no Type II sanitary landfill is planned as part of the remedial action.
- 3) Regulates location of Type II sanitary landfills within 100 feet of adjacent property lines, lakes and streams. This requirement is not an ARAR as no Type II sanitary landfill is planned as part of the remedial action.
- 4) Regulates location of Type II sanitary landfills within 300 feet of domiciles at time of construction. This requirement is not an ARAR as no Type II sanitary landfill is planned as part of the remedial action.

2.6.17 Goemaire-Anderson Wetland Protection Act

Regulates activities that could disrupt wetlands. This requirement is not an ARAR as no wetlands are present at the Auto Ion site.

2.6.18 Water Resources Commission Act, Part 5- Spillage of Oil and Polluting Materials

Storage of salt within 50 feet from the shore of any lake or stream. This requirement is not an ARAR as no salt storage is planned as part of the remedial action.

2.6.19 Endangered Species Act

Regulates endangered or threatened species. This requirement is not an ARAR as no endangered or threatened species are on or nearby the Auto Ion site.

2.6.20 Wilderness and Natural Areas Act

Creates and regulates wilderness and natural areas. This requirement is not an ARAR as the Auto Ion site is not a wilderness area.

2.7 Action-Specific ARARs

Action-specific ARARs are requirements that apply to specific technologies or types of technologies to be used for site remediation. Because of the potentially large number of action-specific regulations to consider, only those technologies that were retained during the screening of alternatives were evaluated for potential action-specific ARARs. Potential Federal action-specific ARARs are presented in Table 2-4. Potential Michigan action-specific ARARs are presented in Table 2-5.

2.7.1 Toxic Substances Control Act

Controls usage, storage and disposal of PCBs. This is not an ARAR as no known PCBs are at the Auto Ion site.

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TABLE 2-4

POTENTIAL FEDERAL ACTION SPECIFIC ARARS

REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Hazardous Waste Management	Resource Conservation and Recovery Act (RCRA)	40 C.F.R. Parts 262-268	Yes
Usage, storage, and disposal requirements for PCBs.	Toxic Substances Control Act	40 C.F.R. Part 761	No
Sets emission standards for designated pollutants	Clean Air Act	42 U.S.CC. sec. 7401-7642	Yes
Sets emission standards for designated hazardous pollutants.	National Emission Standards for Hazardous Air Pollutants	40 C.F.R. Part 61	Yes
Regulates worker health and safety.	Occupational Safety and Health Act	29 U.S.C. sec. 651-678	Yes
Regulates transportation of hazardous wastes and materials.	Hazardous Materials Transportaion Regulations	49 C.F.R. Parts 107, 171-177	Yes

AUTO ION SITE
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TABLE 2-5

POTENTIAL MICHIGAN ACTION SPECIFIC ARARS

REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Controls MI air pollution by regulating an air pollution control commission within the state health department and other certain county agencies.	Air Pollution Act	MI Act 348	Yes
Indicates remedial preferences at sites of environmental contamination.	Environmental Response Act	MI Act 307	Yes
Protects public health and the natural resources of the state by licensing and regulating persons engaged in generating, transporting, treating, storing, and disposing of hazardous waste. It also provides a plan for the safe management and disposal of hazardous waste by establishing a list of criteria for hazardous waste which requires treatment, storage, or disposal at an approved facility.	Hazardous Waste Management Act	MI Act 64	Yes
Regulates inland lakes and streams and protects riparian rights and the public trust in inland lakes and streams.	Inland Lakes and Streams Act	MI Act 346	No

TABLE 2-5 Continued...

REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Enforces persons engaged in removing liquid industrial wastes from the premises of other persons to be licensed and bonded. It also provides for the control of the disposal of wastes.	Liquid Industrial Control Act	MI Act 136	No
This act regulates working conditions including the duties of employers and employees as to places and conditions of employment.	Michigan Occupation Health and Safety Act	MI Act 154	Yes
Provides control of drilling, operating, and abandoning of mineral wells to prevent surface and underground waste. It also enforces the inspection, repairing, and plugging of mineral wells and for entering on private property for that purpose	Mineral Well Act	MI Act 315	No

TABLE 2-5 Continued...

REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
Authorizes the establishment of a system of designated wild, scenic and recreational rivers. It also authorizes the protection of designated river frontage by acquisition, lease, easement or other means. This act has the ability to enforce limitations on uses of land and their natural resources.	Natural River Act	MI Act 231	No
This act protects public health and controls public water supplies. It also issues specifications and construction permits for waterworks systems.	Safe Drinking Water Act	MI Act 399	No
This act provides for the control of soil erosion and protects the water from sedimentation. It also describes the powers, duties and functions of the state and local agencies.	Soil Erosion and Sedimentation Control Act	MI Act 347	Yes

TABLE 2-5 Continued...

REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
This act creates the regulations and management of solid wastes as well as describing the powers and duties of certain state and local agencies and officials.	Solid Waste Management Act	MI Act 641	Yes
This act provides protection and management of shorelands and the zoning ordinances.	Shoreland Protection and Management Act	MI Act 245	No
This act creates a Water Resources Commission to protect and conserve the water resources of the state, to have control over the pollution of any waters in the state and the Great Lakes, to have control over the alteration of the watercourses and the flood plains of all rivers and streams, with powers to make rules governing the same. It also requires permits to regulate the discharge or storage of any substance which may affect the quality of the waters.	Water Resources Commission Act	MI Act 245	Yes

TABLE 2-5 Continued...

REGULATED ACTIVITY	REGULATION	CITATION	POTENTIAL ARAR?
This act provides specifications and issues construction permits of sewerage systems.	Water and Sewerage Act	MI Act 98	No
Any facility which processes, uses, stores, transports, or conveys bulk materials;	Establishment of fugitive dust control programs	Act 348, PA of 1965 R336.1371	Yes

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2.7.2 Michigan Inland Lakes and Streams Act

Regulates inland land and streams, and protects riparian rights. This requirement is not an ARAR as no planned remedial activities will affect the Kalamazoo River.

2.7.3 Natural River Act

Establishes wild and scenic rivers and protects river frontage. This requirement is not an ARAR as the Kalamazoo River is not a scenic river.

2.7.4 Safe Drinking Water Act

Regulates public drinking water supplies and waterworks systems. This requirement is not an ARAR as the groundwater on-site is not part of any public water supply.

2.7.5 Shoreline Protection and Management Act

Regulates and manages shorelines. This requirement is not an ARAR as the Kalamazoo River will not be affected by the remedial activities.

2.7.6 Water and Sewage Act

Provides specifications and issues construction permits of sewage treatment systems. This requirement is not an ARAR as no sewage systems are planned as part of the remedial activities.

3.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

3.1 Introduction

Section 3.0 provides a summary of the process carried out to identify, select, and screen remedial technologies potentially applicable to the groundwater at this site. This activity was carried out in a three step process. First, Remedial Action Objectives were identified based on the data from the RI and the Risk Assessment (RA). Second, General Response Actions (GRA) were identified based on the Remedial Action Objectives. Third, the potentially applicable Remedial Technologies Groups and Process Options associated with each of these GRAs were identified, investigated, and are considered solely according to their technical implementability. Those Remedial Technologies Groups and Process Options which were not determined to be implementable were eliminated from further consideration. Those remaining Remedial Technology Groups and Process Options were retained and screened with respect to effectiveness, implementability, and cost.

3.2 Remedial Action Objectives

The Remedial Action Objectives (RAO) are the specific cleanup objectives for each medium that will result in acceptable levels of risk to human health and the environment based on CERCLA regulations. These cleanup objectives are defined by the results of a risk assessment and by ARARs.

3.2.1 Risk Associated RAOs

The CERCLA Baseline Risk Assessment determined that the human health and environmental risks were acceptable even though there are contaminants in the groundwater, because the humans most likely will not use the groundwater. Therefore there is not an exposure

pathway for humans. The CERCLA Baseline Risk Assessment showed no significant impact from the groundwater discharging into the river.

3.2.2 ARAR Associated RAOs

The principal ARAR that defines the specific cleanup goals for the groundwater at the site is Michigan Act 307, which requires that in cases where the site groundwater has contaminants at concentrations greater than background concentrations, the site groundwater must meet surface water quality criteria at the point of groundwater discharge to the river. Therefore the RAO for the groundwater that discharges to the river are:

Cd	0.70 $\mu\text{g/L}$
Total Cr	85
Hexavalent Cr	2.0
Cu	21
CN	4
Pb	9.7
Hg	0.0013
Ni	63
Va	3.73
Zn	89

These are designated the Type B cleanup requirements. (Some of these values are below the practical quantitation level and therefore the actual RAOs may be set higher at the PQL. Specific requirements must be obtained from MDNR on this point.)

Michigan Environmental Response Act (MERA) provides chemical-specific cleanup criteria depending on the degree of cleanup selected at a site. A Type A cleanup would require that the cleanup be done to background, a Type B cleanup would be done to chemical-specific risk-based numbers. A Type C cleanup is based on a site-specific risk assessment. Type C cleanups are evaluated based on criteria set forth in the MERA administrative rules R 299.5717 and R 229.5719.

This FS evaluates the range of alternatives that covers the requirements of remedy selection under Act 307.

Normally, MCL concentrations established under the Safe Drinking Water Act would be chemical specific ARARs at sites where groundwater is impacted. At this site, however, groundwater is not used for human consumption and will not be used for human consumption under any reasonably foreseeable circumstances. Furthermore institution restriction on groundwater use for human consumption are in place and are likely to remain in place indefinitely. Therefore, MCLs are not RAOs for this site.

RAOs related to RCRA ARARs are MCLs or alternative concentration limits (ACLs) if appropriate based on site specific conditions. It is expected that the site would meet the criteria for applying ACLs and that would be less restrictive than the requirements under ACT 307. Therefore, the range of alternatives evaluated to meet the Act 307 evaluation requirements will satisfy the RCRA criteria as well.

The selection of remedy will be based on nine criteria. The ability of the remedy to meet the stated media specific RAOs as determined in the risk assessment and the RAOs as specified by ARARs are two of the criteria.

Groundwater remediation goals for a Type B and for a Type C cleanup are presented in Table 3-1.

3.3 General Response Actions Applicable To The Auto Ion Site

General Response Actions (GRA) are defined as those actions which, when implemented, would result in the achievement of the Remedial Action Objective (RAO). The three categories

AUTOCLAVE SITE
KALAMAZOO, MICHIGAN

TABLE 3-1
GROUNDWATER REMEDIATION GOALS

FINAL REMEDIATION LEVELS FOR A TYPE B ALTERNATIVE					RESPONSIBLE PARTY PROPOSED TYPE C ALTERNATIVE		
MEDIUM	CHEMICAL	REMEDATION LEVEL (1) ($\mu\text{g/L}$)	POINT OF COMPLIANCE	BASIS OF GOAL	REMEDATION LEVEL (2) ($\mu\text{g/L}$)	POINT OF COMPLIANCE	BASIS OF GOAL
Groundwater	Aluminum	NA	GW Discharge to River	Act 307 Type B Criteria	NA	Southern Boundary of AI site	Michigan Water Quality Standard (5)
"	Arsenic	.02	"	"	12,800,000	"	"
"	Barium	2,000 (4)	"	"	NA	"	"
"	Beryllium	NA	"	"	NA	"	"
"	Cadmium	4 (4)	"	"	48,600 (6)	"	"
"	Calcium	NA	"	"	NA	"	"
"	Total Chromium	7,000 (4)	"	"	5,900,000 (6)	"	"
"	Hexavalent Chromium	100 (4)	"	"	139,000	"	"
"	Cobalt	NA	"	"	NA	"	"
"	Copper	1,000 (4)	"	"	1,480,000 (6)	"	"
"	Cyanide	100	"	"	278,000	"	"
"	Iron	NA	"	"	NA	"	"
"	Lead	4(4)	"	"	673,000 (6)	"	"
"	Magnesium	NA	"	"	NA	"	"
"	Manganese	700	"	"	NA	"	"
"	Mercury	2	"	"	90 (7)	"	"
"	Nickel	100 (4)	"	"	4,370,000 (6)	"	"
"	Potassium	NA	"	"	NA	"	"
"	Sodium	150,000	"	"	NA	"	"
"	Vanadium	NA	"	"	259,000	"	"
"	Zinc	1,000 (4)	"	"	6,180,000 (6)	"	"
"	Chloromethane	3	"	"	NA	"	"
"	Vinyl Chloride	.02	"	"	215,000	"	"
"	Methylene Chloride	5	"	"	4,100,000	"	"
"	Trans-1,2-Dichloroethene	100	"	"	20,800,000	"	"
"	1,2-Dichloroethene (total)	.4	"	"	NA	"	"
"	1,2-Dichloroethane	NA	"	"	38,900,000	"	"
"	Chloroform	6	"	"	2,980,000	"	"
"	Trichloroethene	3	"	"	6,530,000	"	"
"	1,2-Dichlorobenzene	600	"	"	486,000	"	"
"	2,4-Dimethylphenol	400	"	"	NA	"	"
"	2,4,6-Trichlorophenol	3	"	"	104,000	"	"
"	Diethylphthalate	6,000	"	"	NA	"	"

(1) Based on acceptable MDNR Drinking Water Levels.

(2) Water quality standard multiplied by Realistic Worst Case Model Dilution Factor (6.9416 E04). The Dilution Factor was derived by dividing the realistic worst case 95% upper confidence limit concentration of a constituent (see Tables 1-6 and 1-7) by the predicted concentration of the constituent in the river (see Tables 1-17 and 1-18) from the surface water quality model.

This is one methodology to calculate Type C numbers, however, the calculations for Type C criteria used as part of a remedial action may be different.

(3) Method Detection Limit.

(4) Or Background Concentration.

(5) MI Rule 57(2) Guidelines for surface water quality after mixing.

(6) Assumes hardness of 200 mg/L in surface water.

(7) Standard is for Methyl Mercury only.

NA: Not Available.

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of GRAs applicable to groundwater remediation are defined as:

Active Restoration: Active Restoration involves the treatment of groundwater such that the residual chemical levels present are reduced at a rate more rapid than by simple containment or no restoration action. The actions included in the Active Restoration GRA are the extraction and treatment or in-situ treatment of the impacted groundwater. The Active Restoration GRA applicable to the groundwater at this site is: Collection/Treatment/Discharge.

Plume Containment or Gradient Control: Plume containment or gradient control involves the isolation of the impacted groundwater from potential receptors or simply reducing the rate of migration of the residual chemicals. The GRAs of this type applicable to the groundwater at this site are: Collection/Discharge or Containment.

Limited or No Active Response: Limited or No Active Response allows for natural attenuation with some period of monitoring, or treatment of the groundwater for a specific use. The GRAs of this type applicable to the groundwater at this site are: No Further Action and Institutional Controls.

Table 3-2 summarizes the GRAs which were determined to be potentially feasible for groundwater at this site. The GRAs were selected from a comprehensive list of GRAs typically considered for the clean-up of groundwater at hazardous material sites, developed from the October 1988 interim final RI/FS Guidance (EPA, 1988), the revised handbook on Remedial Action at Waste Disposal Sites (EPA, 1985), experience with similar projects, and knowledge of new technologies.

3.4 Identification and Screening of Remedial Technology Groups

A Remedial Technology Group (RTG) refers to general categories of technologies such as physical treatment, extraction, or dewatering.

TABLE 3-2
Summary of Applicable General Response Actions

<u>Category</u>	<u>General Response Action</u>
1) Active Restoration	1a) Collection/Treatment/Discharge
2) Plume Containment or Gradient Control	2a) Collection/Discharge 2b) Containment
3) Limited or No Active Response	3a) No Further Action 3b) Institutional Controls

All RTGs which are potentially applicable with the GRAs associated with groundwater at this site are screened in this section solely on their technical implementability. This screening provides a brief description of each RTG and indicates whether it is potentially applicable or if it can be discarded from further consideration. The results of the identification and screening process of the different RTGs is summarized in Table 3-3. Those RTGs which were not determined to be technically implementable were eliminated from further consideration.

IDENTIFICATION AND SCREENING OF REMEDIAL TECHNOLOGY GROUPS

AUTO ION SITE
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<u>General Response Actions</u>	<u>Remedial Technology Groups</u>	<u>Description of Implementability</u>	<u>Screening Comments</u>
No Further Action	None	No Further Action	Retained
Institutional Controls	Access Restrictions	Deed Restrictions Would Restrict Access to Groundwater	Retained
	Monitoring	Continued Monitoring of Wells	Retained
Collection/ Discharge	Extraction	Used to Remove Groundwater From Deep Aquifers	Retained
	Subsurface Drains	Used to Collect or Divert Groundwater	Retained
	On-site Discharge	Extracted Water Discharged to the Kalamazoo River	Retained
	Off-site Discharge	Extracted Water Discharged to Local POTW for Treatment	Retained

continued
IDENTIFICATION AND SCREENING OF
REMEDIAL TECHNOLOGY GROUPS

AUTO ION SITE
KALAMAZOO, MICHIGAN

<u>General Response Actions</u>	<u>Remedial Technology Groups</u>	<u>Description of Implementability</u>	<u>Screening Comments</u>
Containment	Vertical Barriers	Low permeability Barriers Installed to Contain, Capture, or Direct Groundwater	Retained
	Capping	Minimizes Infiltration	Retained
Collection/ Treatment/ Discharge	Extraction	Used to Remove Groundwater From Deep Aquifers	Retained
	Subsurface Drains	Used to Collect or Divert Groundwater	Retained
	Physical Treatment	Separates the Waste From Waste Water by Applying Force or Changing the Form of the Waste	Retained
	Thermal Treatment	Uses High Temperature Oxidation to Degrade Organic Substances	Discarded – Not Effective on Inorganics or Large Volumes of Water
	Chemical Treatment	Alters the Chemical Structure of the Constituents Present	Retained
	Biological Treatment	Organic Matter is Broken Down to Simpler Substances Via Aerobic and Anaerobic Respiration	Discarded – Would not Treat Inorganics in Groundwater
	On-site Discharge	Extracted Water Discharged to the Kalamazoo River	Retained
	Off-site Discharge	Extracted Water Discharged to Local POTW for Treatment	Retained

4.0 IDENTIFICATION AND SCREENING OF PROCESS OPTIONS

4.1 Introduction

Each RTG is made up of one or more Process Options. A Process Option refers to a particular type of remedial technology. Air stripping and carbon adsorption are examples of two Process Options from the physical treatment technology group. Process Options for those RTGs which survived the initial screening in Section 4.3 are identified and further evaluated in this section. The criteria used to initially evaluate these process options are effectiveness, implementability, and cost.

The effectiveness evaluation concerns the ability of each Process Option to protect human health and the environment. Each Process Option is evaluated with regard to the protection it would provide, and the reduction in volume, toxicity, and mobility it would provide.

The implementability evaluation is designed to assess both the technical and administrative feasibility of constructing, operating, and maintaining a Process Option. Additionally, the availability of the Process Option is evaluated.

The cost evaluation is used to evaluate and, where appropriate, reject any similar Process Options within a Remedial Technology which do not provide a greater degree of public health and environmental protection than other more cost effective option(s).

These criteria include the following basis for the selection or rejection of a Process Option:

- Selection of the Process Option that has a demonstrated history of successful use in environments similar to the Auto Ion site. All Process Options, unless of a research and development nature, which can be reasonably said to be in common use, will be retained.

- Process Options which have or imply an excessively long period between implementation and remedial effect, or which have long permitting delays before implementation, will be rejected unless there is no other Process Option that can achieve the RAO in a more timely manner.
- Process Options which are, or must be implemented in concert with (or linked to) another technology or option which is rejected, will also be rejected.
- Process Options which are significantly more expensive than other Process Options without providing additional benefits will be rejected.

4.2 Screening of Process Options

Each Process Option includes a description and a discussion of effectiveness and an initial screening summary. A discussion of implementability and/or cost may not be included if the Process Option is being rejected based on the other discussions already presented. Process Options are listed under their corresponding GRA.

4.3 GRA: No Further Action

4.3.1 Remedial Technology: None.

4.3.1.1 Process Option: Not Applicable.

Description: A "No Further Action" alternative assumes no remedial actions would be taken and must be retained throughout the FS as a baseline against which other alternatives can be measured. Groundwater concentrations would be expected to decrease over time due to natural flushing of the groundwater system, degradation, dilution and attenuation.

The No Further Action alternative would include the other remedial activities which have been completed or are in progress, including the surface removal action and source control soil excavation which will eliminate all sources of groundwater impacts from the Auto Ion site.

Initial Screening: This remedial option must be retained in accordance with CERCLA requirements.

4.4 GRA: Institutional Controls

4.4.1 Remedial Technologies: Access Restrictions and Groundwater Monitoring

4.4.1.1 Process Options: Deed Restrictions and Groundwater Monitoring

Description: Institutional Controls is a GRA made up of a set of Process Options which can be used to control the use of groundwater which has been impacted. These options can be used to manage impacted groundwater and minimize risks to public health. They include the following actions:

- Prohibit the use of impacted groundwater through deed restrictions and/or administrative rules; and,
- implement groundwater monitoring to assure that concentration levels in groundwater do not exceed action levels.

Effectiveness: These options may not reduce on-site concentrations. However, they would reduce exposure possibilities and help protect human health and the environment. These Process Options could also act as a temporary measure until remediation can be completed.

Implementability: There are no private or public wells near the site using water from the impacted groundwater zone for drinking water uses. The City of Kalamazoo already enforces an ordinance which controls the installation of wells and the use of extracted groundwater. In

addition, a fence has been installed that restricts access to the site and monitoring wells have also been installed. These options appear to be easily implemented.

Cost: These options appear to be cost effective.

Initial Screening: These Process Options will be retained for further evaluation as a remedial alternative and as a possible sub-component of other alternatives.

4.5 GRA: Containment

4.5.1 Remedial Technologies: Vertical Barriers

4.5.1.1 Process Option: Slurry Wall

Description: A slurry wall is a subsurface barrier installed in a vertical trench. The slurry wall trench is excavated from grade using conventional construction equipment. A slurry, usually a bentonite-soil-water mixture is introduced during the excavation to keep the trench from collapsing. The slurry wall would completely encircle the Auto Ion site. Slurry walls are differentiated by the mixture of materials used in the slurry. The mixture must be impermeable, not degradable by the compounds present, and have the strength to withstand subsurface hydrostatic forces.

Effectiveness: A slurry wall, made of the proper mixture of bentonite and soil, could effectively contain impacted groundwater. The entire area inside the slurry wall would have to capped in order to prevent hydraulic loading, which could cause the release of the impacted groundwater.

In some situations a slurry wall is also installed as a vertical barrier on the downgradient side of a plume to manipulate the flow of groundwater in sites adjacent to surface water bodies. These walls, in conjunction with a subsurface drain, are often used to cut off recharge flow from

the surface water body so that only the contaminated portion of the groundwater is collected. To be effective, the hanging wall must be keyed into a low permeable formation so that groundwater does not flow under the barrier material.⁵

Implementability: A full depth bentonite slurry wall would have to be keyed into the Mississippian age Coldwater Shale underlying the Auto Ion Site. The RI estimated this confining layer to be at approximately 110 feet below grade. A slurry wall can be installed at this depth although it would be difficult and the integrity would be questionable. To capture the variable groundwater flow it would have to extend off-site. Access to these off-site areas would not be feasible due to major structures, including Mills Street (utilities and bridge) and the Production Painting building.

A partial, or hanging, slurry wall could be installed in conjunction with a sub-surface drain. However, the construction aspect of a wall located along the river could prove difficult.

Cost: This full depth wall may not be cost effective if it is installed to a depth of 110 feet or more. A hanging wall may be cost-effective.

Initial screening: Although this option may not be implementable or cost-effective, it will be retained as a possible sub-component of a hanging wall/sub-surface drain groundwater collection option.

4.5.1.2 Process Option: Sheet Pile

Description: Sheet piling refers to a process where interlocking pieces of impermeable material are pushed into the ground around the impacted area. The sheets, usually steel, are driven into the ground using a crane equipped with a vibrating hammer.

⁵ Leachate Plume Management EPA/540/2-85/004

Effectiveness: The primary drawback of sheet piling is the problem with subsurface obstructions, such as rocks. Damage to or deflection of the piles is likely to render a wall ineffective as a groundwater barrier.

Implementability: Depth to which sheet pile can be driven is constrained by the type of soil present and the installation equipment. In order to effectively contain the impacted groundwater, a sheet pile barrier wall would have to be keyed into the confining layer at 110 feet below the Auto Ion site. It would not be feasible to install sheet piling to this depth.

Sheet piling is also used as a downgradient vertical barrier in some applications. However, with the variability of groundwater flow at the site, the positioning of the sheet pile barrier would be impractical. It would be necessary to install it through the Production Painting facility, as well as across Mills Street (utilities and bridge) in order to effectively contain groundwater.

Initial Screening: The 110 foot depth to the confining layer at the site is well beyond the capacity of a sheet pile installation. Because the sheet pile could not be tied into the confining layer, groundwater would be able to migrate under this type of barrier. For this reason, this Process Option has been eliminated from further consideration.

4.5.1.3 Process Option: Grout Injections

Description: Grout injections are used to control groundwater flow by injecting a grouting fluid into a rock or unconsolidated formation. This is often accomplished using a drill rig to bore a hole into which the grout is introduced. The type of grout used is dependent on site specific conditions. Groundwater at the site would need to be completely encircled by the injected grout.

Effectiveness: As in the other barrier walls discussed above, to be effective, the grout injections must be keyed into the confining layer below the site, and encircle the site as a homogenous curtain. The impermeability of a grout curtain is primarily based on a sufficient number of grout injections in close proximity to create a homogenous barrier. However, a study

has indicated that conventional injection grouting cannot form a reliable barrier in sand (Remedial Action at Hazardous Waste Sites, USEPA, 1985). Effectiveness is questionable.

Initial Screening: Due to the sand layer extending to the confining layer on site, and since this process option is not reliable in sand, it has been eliminated from further consideration.

4.5.1.4 Process Options: Deep Soil Mixing

Description: Deep soil mixing is a process by which stabilization agents are added to contaminated soil in order to bind up the contaminant and thereby immobilize the wastes.

Effectiveness: This process is most often used as a source control measure. Deep soil mixing as a groundwater containment measure is not readily effective.

Initial Screening: Because this technique is not effective in containing groundwater, it has been eliminated from further consideration.

4.5.2 Remedial Technologies: Capping

4.5.2.1 Process Option: Capping

Description: For groundwater remedial actions, capping is generally used as a source control measure to prevent vertical migration of contaminants through the unsaturated zone to the groundwater. Since source control remediation has already been taken care of, capping would only be used to prevent infiltration of clean water into the groundwater.

Effectiveness: The only application of this option would be in conjunction with a containment action where vertical barrier walls isolate the groundwater. For this type of option, containment would be necessary to keep infiltration out of the containment area.

Implementability: This option would be easy to implement.

Cost: This option would be cost effective.

Initial Screening: This option will be retained as a subcomponent of the vertical barrier wall containment response alternative.

4.6 GRA: Collection/Discharge

4.6.1 Remedial Technologies: Extraction

4.6.1.1 Process Option: Extraction Wells

Description: Extraction wells are primarily used to remove groundwater in deep or shallow aquifers that are highly permeable. The selection of the appropriate well type depends on the hydrogeologic characteristics of the site, as well as the remedial objective.

Effectiveness: Pumping wells are most effective where underlying aquifers have high intergranular permeability. The saturated zone underlying the site consists of approximately 90 feet of sand. However, once extracted, the impacted groundwater will require treatment or handling prior to disposal.

Implementability: This technology appears, in general, to be easy to implement.

Cost: This type of technology appears to be cost effective and may represent an alternative for groundwater extraction.

Initial Screening: Extraction wells will be retained for further evaluation as a subcomponent of a remedial alternative involving groundwater treatment.

4.6.1.2 Process Option: Extraction/Injection Wells

Description: This option involves the on-site discharge of groundwater following extraction. This method of discharge is used to manipulate the hydrogeologic conditions at the site. Injection wells and leaching pits are frequently used in conjunction with groundwater removal activities to direct or collect groundwater. A series of injection wells can be used to flush an aquifer to an extraction well or create a hydraulic wall to redirect flow. Leaching pits are often used to move contaminants from the unsaturated zone into the groundwater where they can be effectively removed.

Effectiveness: It would be difficult to use on-site disposal to manipulate the groundwater flow at the Auto Ion site. Due to the size of the site and fluctuations in the direction of groundwater flow, placement of the injection wells or leaching pits would be difficult.

Implementability: This option could not be easily implemented due to the size of the site and characteristics of the aquifer.

Cost: Shallow injection wells and leaching pits are relatively inexpensive to install and operate.

Initial Screening: Due to poor effectiveness and implementability, this option is eliminated from further consideration.

4.6.2 Remedial Technology Group - Subsurface Drains

4.6.2.1 Process Option: Interceptor Trenches

Description: Interceptor trenches are used to either collect or divert groundwater. Diversion trenches are installed upgradient from the waste source and diverts the groundwater to an uncontaminated area. Collection trenches are installed downgradient from the waste source or plume and collect the contaminated water for subsequent treatment.

Effectiveness: These trenches are most effective for shallow groundwater contamination, especially for floating product, and where aquifer permeabilities are very low. Interceptor trenches may be effective at this site if used in conjunction with a hanging wall.

Implementability: Although implementable, the cost of dewatering and shoring can make construction of even shallow drains difficult.

Cost: The operation and maintenance of subsurface drains can be substantially lower than groundwater pumping wells.

Initial Screening: This option is retained as a possible low volume, low maintenance method of groundwater collection.

4.6.3 Remedial Technologies: Off-Site Disposal

4.6.3.1 Process Option: Publicly Owned Treatment Works/Privatey Owned Treatment Works

Description: The two disposal options that are most commonly used for untreated groundwater are: 1) a Publicly Owned Treatment Works (POTW); and 2) a privately owned and operated water treatment plant. Under both options the water is extracted from the ground, transported to a treatment facility, treated, and discharged to an adjacent surface water stream.

Effectiveness: This option represents an effective way to deal with the groundwater at the Auto Ion site. The city's activated sludge treatment plant would be expected to effectively reduce the inorganic and organic content. There are numerous industrial wastewater treatment facilities that could be expected to effectively treat the groundwater.

Implementability: This option may be easy to implement. A sewer main for the Kalamazoo POTW runs near the site. The extracted groundwater could probably be plumbed to the sewer. Treatment by the privately-owned treatment facilities would require installation of a dedicated pipeline or over-the-road hauling.

Cost: The capital cost of installing a line to the sewer would be expected to be relatively inexpensive. The POTW charge for treating the waste water could result in a high disposal cost. It may be feasible to negotiate these costs with the City. Batch transportation or pipeline construction and treatment at a privately owned facility represents a much higher cost.

Initial Screening: The POTW option is retained for further evaluation as a subcomponent of a remedial alternative involving groundwater extraction. The privately-owned treatment works option is eliminated due to high costs.

4.6.4 Remedial Technologies: On-site Disposal

4.6.4.1 Process Option: Discharge to Kalamazoo River

Description: This option involves the off site disposal of treated groundwater. Following extraction and treatment, under other Process Options, this option would involve discharging of the treated water to the Kalamazoo River.

Effectiveness: This off site disposal method is a widely acceptable method for the disposal of treated water.

Implementability: This option appears to be easy to implement. The Kalamazoo River and city sewer are adjacent to the site.

Cost: Discharge to surface waters appears to be a low cost option for the disposal of the treated water.

Initial Screening: This option is retained for further consideration as a subcomponent of a remedial alternative involving groundwater extraction and treatment.

4.7 GRA: Collection/Treatment/Discharge

4.7.1 Remedial Technologies: Extraction

The Process Options under this RTG are the same as that discussed above under the Collection/Discharge GRA.

4.7.2 Remedial Technologies: Subsurface Drain

The Process Options under this RTG are the same as that discussed above under the Collection/Discharge GRA.

4.7.3 Remedial Technologies: Physical Treatment

4.7.3.1 Process Option: Air Stripping

Description: Air stripping is a mass transfer process where the volatile organics are transferred from the water to the vapor phase. This process is accomplished using a packed tower with a counter current of air. The contaminated water flows through the tower in one direction while the air is forced through the tower in the other.

Effectiveness: Volatile organics have an affinity for the vapor phase and tend to leave the liquid phase in the air stream. Organic compounds with Henry's Law constant of 0.003 or greater can be removed. The volatile organics of concern at this site have a Henry's Law constant of greater than 0.003. The concentrations of these compounds are relatively low with a maximum measured concentration of 560 ppb. Air stripping is often only partially effective for completely removing volatile organics and is usually followed by activated carbon. However, this treatment does not remove inorganics or non-volatile organics.

Implementability: This option appears, in general, to be readily implementable.

Cost: The installation, operation and maintenance costs of this process option does not appear to be excessive.

Initial Screening: This option will be retained for further evaluation as a subcomponent of a treatment alternative.

4.7.3.2 Process Option: Vacuum Extraction

Description: Mechanical aeration/extraction entails contacting clean air with the contaminated groundwater to transfer the volatile organics from the water into the gaseous phase.

Effectiveness: Volatile organics of concern at this site can be removed using this technology, however, this treatment does not remove inorganics or non-volatile organics. Air stripping would be more effective at removing these compounds.

Initial Screening: This option is not as effective on volatile organics in groundwater as air stripping, so it will no longer be considered.

4.7.3.3 Process Option: Steam Stripping

Description: Steam stripping uses steam to evaporate organics from aqueous wastes. Steam stripping will treat less volatile and more soluble wastes than air stripping, at much higher concentrations. Steam stripping is usually used for the removal of heavier organics, such as chlorinated hydrocarbons and aromatics.

Effectiveness: This process can remove both light and heavy organics. The organics of concern at the Auto Ion site are light volatiles and could easily be removed using this technique. However, this technique will not remove inorganics.

Implementability: This option appears to be easily implemented.

Costs: Operating costs are much higher than air stripping due to the additional energy costs.

Initial Screening: Because the organic compounds at the site can be effectively and more efficiently removed by air stripping, this option will be no longer considered.

4.7.3.4 Process Option: Distillation

Description: Distillation is a unit process that separates components of a liquid or sludge mixture by partially vaporizing the mixture and separately recovering the vapors and residue. The more volatile components of the original mixture concentrates in the vapor while the less volatile components concentrate in the residue.

Effectiveness: This technique is used to separate two liquids with different boiling points that are relatively immiscible in each other. Distillation will remove large amounts of one compound while leaving the other relatively intact. It is used to separate concentrated liquids, but will not achieve complete separation. Dilute amounts of the liquid will be detectable in each other. It is not effective for removal of low concentrations of organics in water.

Initial Screening: Distillation is not applicable for dilute waste streams like the groundwater at the site, and therefore is eliminated from further consideration.

4.7.3.5 Process Option: Filtration

Description: Filtration is a process where suspended solids are removed from solution by forcing a liquid through a porous medium. Granular media is commonly used for filtering aqueous waste streams. Filters are used in reducing the suspended solids level from 200 mg/l to less than 10 mg/l. Waste streams with solids levels above 200 mg/l usually use sedimentation prior to filtration. Inorganic compounds in dilute concentrations can often be effectively filtered from a

liquid after flocculation, however, if the inorganics of concern are in very low concentrations it may not be feasible to convert the compounds into a solid matrix using flocculation.

Effectiveness: This option represents a reliable and effective way to remove low levels of solids from wastes. The inorganics of concern are dissolved and would need to be converted to a solid matrix. This process, in tandem with other processes which could convert the dissolved inorganics to a solid matrix, may be able to effectively remove the inorganic compounds present at the site.

Implementability: Filtration is an accepted process and there are a number of equipment manufacturers that can provide the necessary equipment.

Cost: This option appears to be cost effective.

Initial Screening: This option will be retained for further evaluation as a potential subcomponent of a treatment alternative.

4.7.3.6 Process Option: Membrane Separation

Description: Membrane separation isolates solutes or contaminants from liquids through the use of semi-permeable membranes. Semi-permeable membranes function by selectively rejecting contaminants based on pore size, ion valence, or coprecipitation. Membrane separation processes can be used for volume reduction, purification, concentration and or recovery of contaminants. Membrane selection is specific to the material to be removed.

Effectiveness: Multicharged cations and anions are easily removed from waste water using this technique, while low molecular weight dissolved organics are not removed or are only partially removed. Colloidal and organic matter can clog the membrane, reducing it's efficiency.

Implementability: The wide variations of contaminants present at the Auto Ion site would require various types of membranes making implementation difficult. The process is considered undemonstrated and has not been widely used at hazardous material sites.

Initial Screening: Due to implementability problems this option will not be evaluated further.

4.7.3.7 Process Option: Dissolved Air Flotation

Description: Dissolved Air Floation is used for separating solid/liquid or liquid/liquid suspensions with different specific gravities. The process is used to separate emulsified oils from water by first dissolving air into water and then dropping the pressure. Tiny air bubbles are generated throughout the water phase and the oils accumulate at the air-water interface. The oils are then carried to the surface by the air bubbles and are skimmed off the top of the chamber. Immiscible oily liquids in water, two phase leachates, and hydrophobic chemicals can be treated with phase separation. The technology is not appropriate for dissolved contaminants.

Effectiveness: Groundwater at the Auto Ion site only contains dissolved analytes and compounds. This process would not be effective at this site.

Initial Screening: Due to ineffectiveness, this process is inappropriate and will not be considered further.

4.7.3.8 Process Option: Activated Carbon Adsorption

Description: The activated carbon adsorption process is used for the removal of trace organic compounds from aqueous solutions. Adsorption is a surface phenomenon in which soluble molecules from a solution are bonded onto a particular substrate.

Effectiveness: Carbon adsorption can be applied to groundwater containing a wide range of organic compounds. It can be used as the primary treatment method for organics, or as a secondary treatment method for the treatment of the vapor from air stripping.

Implementability: Carbon adsorption is a well developed process which is widely used for the removal of organics from groundwater. There are a large number of firms offering equipment and engineering expertise in this area.

Cost: This option appears to be a cost effective way to remove dilute organics from groundwater.

Initial Screening: This option is retained for further consideration as a subcomponent of a groundwater collection and treatment alternative.

4.7.3.9 Process Option: Sludge Extraction

Description: The sludge extraction process is based on the critical solution point of water and a solvent to remove water and oily material from sludge or solids. This process requires the excavation of the affected area and the addition of a solvent to bring the oily material into solution.

Effectiveness: Chemical residues present at the site in the groundwater are in solution and no oily wastes or sludges are present. This technology will not effectively treat the groundwater.

Initial Screening: This process is eliminated from further consideration because it would not be effective at treating the chemical residues in the groundwater.

4.7.3.10 Process Option: Ion Exchange

Description: Ion Exchange removes metal ions from solution by exchanging one ion,

electrostatically attached to a solid resin material, for a dissolved ion. The resulting residuals include spent resins and spent regenerants such as acid, caustic or brine.

Effectiveness: This process is used to treat metal wastes including cations (Ni^{2+} , Cd^{2+} , Hg^{2+} , Fe^{2+} , Ca^{2+}) and anions (CrO_4^{2-} , SeO_4^{2-} , HAsO_4^{2-}). Limitations of this process are selectivity/competition, pH, and suspended solids.

Implementability: This option is commercially available and generally readily implementable. It has been used on full commercial scale for water treatment/conditioners.

Cost: This option appears to be a cost effective way to remove inorganics from groundwater.

Initial Screening: This option will be retained for further consideration.

4.7.4 Remedial Technology: Chemical Treatment

4.7.4.1 Process Option: Chemical Oxidation and Reduction

Description: Chemical oxidation is a process which increases the oxidation state of matter by removing electrons or adding oxygen to the atom. As a result of oxidation, a substance may be transformed, degraded, and/or immobilized. Oxidizing agents may be utilized to degrade organic constituents in wastes. Some oxidizing agents are: Ozone, hypochlorite, hydrogen peroxide, chlorine, potassium permanganate and UV/ozone. Heavy metal oxidation is not usually an effective treatment method because the higher the oxidation state, the more mobile the heavy metal tends to be.

Chemical reduction is a process in which the association state of an atom is decreased. Reducing agents are electron donors, with reduction accomplished by adding electrons to the atom. Chemical reduction occurs naturally within some ecosystems. Certain compounds are more

susceptible to reduction than others because they will readily accept electrons. Some reducing agents are: ferrous sulfate, sodium sulfate, sulfur dioxide, iron (+2), aluminum, zinc, and sodium borohydride.

Effectiveness: Oxidation and reduction are not generally effective as remedial treatment process when there is a variety of contaminants, such as at the Auto Ion site. A wide diversity of compounds may complicate the process and produce undesirable side effects. For example, increasing the oxidation state of heavy metals generally increases their mobility.

Initial Screening: Due to the poor effectiveness of this option for this site, it will no longer be considered further.

4.7.4.2 Process Option: Neutralization

Description: Neutralization is the interaction of an acid ($\text{pH} < 5$) or a base ($\text{pH} > 9$) with a solution such that the pH of the resulting solution or mixture is between 5 and 9 standard units. The equipment for neutralization usually consists of a chemical feed system and a rapid mixing process, followed by another physical or chemical process for by-product removal as appropriate. Sodium hydroxide, lime, or sulfuric acid are the most common reagents used to neutralize a waste. This process is used most often on liquid waste streams.

Effectiveness: The groundwater at the Auto Ion site is considered pH neutral.

Initial Screening: Since no additional neutralization is necessary, this process is eliminated from further consideration.

4.7.4.3 Process Option: Precipitation/Flocculation/Sedimentation

Description: Precipitation is the process in which dissolved chemical species in solution are

transformed into solid phases for removal. The chemical equilibrium relationships between the soluble substances are generally altered by the addition of chemicals such as lime and sodium sulfate.

Flocculation is a process in which small suspended particles are transformed into large particles which are able to settle by the addition of chemicals. Typically, the chemicals used for flocculation are alum, lime, and polyelectrolyte. The flocculation agents are first rapidly mixed to disperse the agents, then the solution is slowly and gently mixed to allow the formation of larger particles.

Sedimentation is the process in which suspended particles in an aqueous solution are allowed to settle through the process of gravity.

Effectiveness: The precipitation process is particularly well suited for treating aqueous solutions containing heavy metals and suspended solids. It is applicable for the removal of most metals from waste water. It is possible to use this process for several inorganics at low concentrations. However, this process will not effectively treat organic compounds. Cyanides and some organics may complex with the metals, making the treatment by precipitation more difficult.

Implementability: This option appears to be easy to implement. It has been employed in the treatment of water and waste water for many years. The equipment and expertise necessary to engineer and install this process, as a subcomponent of a large process, are readily available.

Cost: This option can be a cost effective method to treat inorganics in water.

Initial Screening: Due to the ability to effectively treat inorganics in groundwater, this option will be retained for further evaluation as a subcomponent of a treatment alternative.

4.7.4.4 Process Option: Dechlorination

Description: This is a process in which chlorine is chemically removed from chlorinated organic compounds such as PCBs and dioxins. The mechanism for dechlorination involves nucleophilic displacement of chlorine atoms by polyethylene glycol, to form an alkali metal chloride (KCl or NaCl) and a substituted organic polymer.

Effectiveness: This system is used primarily for dechlorination of transformer fluids and is not effective for low level chlorinated organics in large volumes of water. No PCBs or dioxin have been found in the groundwater. This technology is not effective for non-chlorinated organics or inorganics.

Implementability: This technology has not been demonstrated or used on groundwater and would be considered an unproven technology.

Initial Screening: Due to poor effectiveness and implementability this technology will not be considered further.

4.7.5 Remedial Technologies: On-Site Discharge

The Process Options under this RTG are the same as that discussed above under the Collection/Discharge GRA.

4.7.6 Remedial Technologies: Off-Site Discharge

The Process Options under this RTG are the same as that discussed above under the Collection/Discharge GRA.

4.8 Summary

A summary of the process options that persist subsequent to the screening are presented in Table 4-1 . These options are further discussed during the listing of the preliminary remedial alternatives.

IDENTIFICATION AND SCREENING OF PROCESS OPTIONS

AUTO ION SITE
KALAMAZOO, MICHIGAN

<u>General Response Actions</u>	<u>Remedial Technology Groups</u>	<u>Process Options</u>	<u>Retained</u>	<u>Eliminated</u>
No Action	None	Not Applicable	X	
Institutional Controls	Access Restrictions	Deed Restrictions	X	
	Monitoring	Groundwater Monitoring	X	
Collection/ Discharge	Extraction	Extraction Wells Extraction/Injection Wells	X	X
	Subsurface Drains	Interceptor Trenches	X	
	On-site Discharge	Kalamazoo River	X	
	Off-site Discharge	Private Treatment Works Publicly Owned Treatment Works	X	X
Containment	Vertical Barriers	Slurry Walls Sheet Pile Grout Injection Deep Soil Mixing	X	X X X
	Capping	Capping	X	

continued IDENTIFICATION AND SCREENING OF PROCESS OPTIONS

AUTO ION SITE
KALAMAZOO, MICHIGAN

<u>General Response Actions</u>	<u>Remedial Technology Groups</u>	<u>Process Options</u>	<u>Retained</u>	<u>Eliminated</u>
Collection/ Treatment/ Discharge	Extraction	Extraction Wells	X	
		Extraction/Injection Wells	X	
	Subsurface Drains	Interceptor Trenches		X
	Physical Treatment	Air Stripping	X	
		Vacuum Extraction		X
		Steam Stripping		X
		Distillation		X
		Filtration	X	
		Membrane Separation		X
		Dissolved Air Flotation		X
		Activated Carbon Absorbtion	X	
		Sludge Extraction		X
		Ion Exchange	X	
	Thermal Treatment	Previously Eliminated		
	Chemical Treatment	Chemical Oxidation and Reduction		X
		Neutralization		X
		Precipitation/Flocculation/Sedimentation	X	
		Dechlorination		X
	Biological Treatment	Previously Eliminated		
	On-site Discharge	Kalamazoo River	X	
	Off-site Discharge	Private Treatment Works		X
		Publicly Owned Treatment Works	X	

5.0 DEVELOPMENT OF ALTERNATIVES

Remedial action alternatives were developed by uniting the technologies listed in Table 4-1 into assorted groupings of technologies and process options which may be capable of addressing the remedial action objectives. These alternatives are listed in Table 5-1, and are described briefly in the following summary.

The collective uncertainties regarding the source of groundwater contamination identified in Section 1.3 of this report, coupled with the fact that the Baseline Risk Assessment determined that there are no adversely impacted receptors, provide a strong technical basis for not conducting any active groundwater remediation until these uncertainties can be resolved. The Preamble to the NCP states that "such factors as location, proximity to population, and likelihood of exposure may allow much more extended time frames for remediating groundwater".

5.1 Alternative 1 - No Further Action

The No Further Action alternative is intended to be used as a baseline against which other alternatives may be compared. This alternative, as applied to OU II of the Auto Ion site specifies that no additional remedial actions would be taken to remediate groundwater at the site.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-

Table 5-1
Auto Ion FS - OU II
Summary of Remedial Action Alternatives

Alternative 1 - No Further Action

Alternative 2 - Natural Attenuation/Institutional Controls

Alternative 3 - Slurry Wall/Cap

Alternative 4 - High Flow Extraction/Discharge to Publicly Owned Treatment Works (POTW)

Alternative 5 - Groundwater Containment Via Low Flow Extraction/Metals Treatment/Filtration/
Discharge to a POTW

Alternative 6 - High Flow Groundwater Extraction/Metals Treatment/Filtration/Discharge to a
POTW

Alternative 7 - Groundwater Containment Via Low Flow Extraction/Metals Treatment/Filtration/
Activated Carbon Adsorption/Discharge to the Kalamazoo River

Alternative 8 - High Flow Groundwater Extraction/Metals Treatment/Filtration/Activated Carbon
Adsorption/Discharge to the Kalamazoo River

Alternative 9 - Groundwater Containment Via Low Flow Extraction/Metals Treatment/Filtration/
Air Stripping/Activated Carbon Adsorption/Discharge to the Kalamazoo River

Alternative 10 - High Flow Groundwater Extraction/Metals Treatment/Filtration/Air Stripping/
Activated Carbon Adsorption/Discharge to the Kalamazoo River

* Metals Treatment would mean either ion exchange or precipitation/ flocculation/sedimentation,
based on the results of a bench top and/or pilot scale treatability study.

site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

The Baseline Risk Assessment determined that no receptors will be adversely impacted during the period of natural attenuation of groundwater constituents. Existing institutional controls are expected to prevent the use of the groundwater as a well water source during the time required for natural attenuation to occur.

5.2 Alternative 2 - Natural Attenuation/Institutional Controls

This alternative involves the continued periodic inspection and monitoring of the site, while the groundwater is allowed to naturally attenuate. Administrative controls that prevent the use of this groundwater are already in place. They include the state and county health departments restriction on the installation of wells in this area Act 399, P.A., Michigans Safe Drinking Water Act and the City of Kalamazoo's water supply system well site selection criteria and expansion plans. Additional redundant controls such as deed restrictions could also be used. As part of the OUII Remedial Design, Alternate Concentration Limits, (ACLs) will be developed. The ACLs will be used throughout the monitoring to assure they are not exceeded. Included in the OUII Remedial Design will be a contingency plan to respond in the event the ACLs are exceeded.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

The Baseline Risk Assessment determined that no receptors will be adversely impacted during the period of natural attenuation of groundwater constituents. Existing institutional controls are expected to prevent the use of the groundwater as a well water source during the time required for natural attenuation to occur. Also, as concluded in the March 1993 Sediment Toxicity Evaluation Report, there would not be a measurable effect on water quality due to the large flow in the river as compared to the groundwater flux to the river. The results of the evaluation also supports a similar conclusion that there is no discernible impact on the aquatic macroinvertebrate community of the Kalamazoo River.

5.3 Alternative 3 - Slurry Wall/Cap

The alternative involves the containment of impacted groundwater on-site by the construction of a slurry wall around the perimeter of the site. The slurry wall would be constructed of a soil/bentonite mixture and would be keyed into the confining layer existing approximately 110 feet below the ground surface. The objective of this alternative would be to contain any impacted groundwater and eliminate further migration. A cap would be used to minimize any infiltration of precipitation and runoff.

This alternative would include a monitoring program to ensure that the impacted groundwater does not migrate from the containment area.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

5.4 Alternative 4 - High Flow Extraction/Discharge to Publicly Owned Treatment Works (POTW)

The extraction and POTW discharge alternative involves extracting the impacted groundwater from the aquifer and discharging it to a POTW. The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II Remedial Design phase. The extracted groundwater would be discharged through the sanitary sewer for treatment at the City of Kalamazoo's POTW.

This alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing. The discharge to the sanitary sewer would also be monitored to comply with any limits on the discharge to the POTW.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

5.5 Alternative 5 - Groundwater Containment Via Low Flow Extraction/Metals Treatment/Filtration/Discharge to a POTW

This extraction, pretreatment, and off-site disposal alternative involves containing the impacted groundwater and eliminating any further migration by extracting impacted groundwater from the aquifer at a low flow rate, pretreating the extracted groundwater using an on-site treatment system, and discharging the pretreated water to the sanitary sewer for treatment at the

City of Kalamazoo's POTW. The intent of this alternative would be to contain the groundwater on site by depressing the water table.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II Remedial Design (RD) phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be determined during the OU II RD, and may require bench-top and/or pilot scale treatability studies of ion exchange and precipitation/ sedimentation/flocculation and filtration processes.

Based on the expected quality of the extracted groundwater and preliminary information regarding the City's pretreatment requirements, only a few specific metals may preclude the direct discharge of extracted groundwater to the POTW.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/sedimentation/flocculation process to remove inorganics; and filtration to reduce solids loading. The pretreated water would then be discharged directly to the POTW.

The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

5.6 Alternative 6 - High Flow Groundwater Extraction/Metals Treatment/Filtration/Discharge to a POTW

This extraction, pretreatment, and off-site disposal alternative involves actively remediating the aquifer by extracting the groundwater from the impacted saturated zone of the aquifer at a high flow rate, pretreating the extracted groundwater using an on-site treatment system, and discharging the pretreated water to the sanitary sewer for treatment at the City of Kalamazoo's POTW. The intent of this alternative would be to actively restore the aquifer by pumping and treating the impacted groundwater.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be determined during the OU II RD, and may require bench-top and/or pilot scale treatability studies of ion exchange and precipitation/sedimentation/flocculation and filtration processes.

Based on the expected quality of the extracted groundwater and preliminary information regarding the City's pretreatment requirements, only a few specific metals may preclude the direct discharge of extracted groundwater to the POTW.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/sedimentation/flocculation process to remove inorganics; and filtration to reduce solids loading. The pretreated water would then be discharged directly to the POTW.

The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

5.7 Alternative 7 - Groundwater Containment Via Low Flow/Extraction/Metals Treatment/ Filtration/Activated Carbon Adsorption/Discharge to the Kalamazoo River

This extraction, treatment, and off-site disposal alternative involves containing the impacted groundwater and eliminating any further migration by extracting impacted groundwater from the aquifer at a low flow rate, treating the groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River. The intent of this alternative would be to contain the groundwater on-site by depressing the water table.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top and/or pilot scale treatability studies of ion exchange and precipitation/sedimentation/flocculation processes.

The effluent would be discharged directly into the Kalamazoo River and would meet National Pollution Discharge Elimination System (NPDES) requirements. Based on the expected quality of the extracted groundwater and preliminary information from the MDNR regarding

NPDES discharge limitations, a number of the metals would have to be reduced in concentration before discharging to the river. Based on experience in similar applications, the appropriate metals treatment for this alternative would be precipitation/flocculation/sedimentation.

This alternative differs from Alternative five due to level of treatment required and where the effluent is discharged. Discharging the treated water into the Kalamazoo River would meet NPDES requirements, which would require the treatment of organics and inorganics to meet more stringent limits. Due to the larger number of metals being treated under this alternative, it is expected that this treatment would be performed more effectively by the precipitation/flocculation/sedimentation process.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; and, activated carbon adsorption to reduce the organic loading.

The treated water would then be discharged directly to the Kalamazoo River. The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

5.8 Alternative 8 - High Flow Groundwater Extraction/Metals Treatment/Filtration/Activated Carbon Adsorption/Discharge to the Kalamazoo River

This extraction, treatment, and off-site disposal alternative involves actively remediating the aquifer by extracting the groundwater from the impacted saturated zone of the aquifer at a high flow rate, treating the extracted groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River. The intent of this alternative would be to actively restore the aquifer by pumping and treating the impacted groundwater.

The groundwater would be extracted by a system using a combination of extraction wells subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top and/or pilot scale treatability studies of ion exchange and precipitation/sedimentation/ flocculation processes.

The effluent would be discharged directly into the Kalamazoo River and would meet National Pollution Discharge Elimination System (NPDES) requirements. Based on the expected quality of the extracted groundwater and preliminary information from the MDNR regarding NPDES discharge limitations, a number of the metals would have to be reduced in concentration before discharging to the river. Based on experience in similar applications, the appropriate metals treatment for this alternative would be precipitation/flocculation/sedimentation.

This alternative differs from Alternative six due to level of treatment required and where the effluent is discharged. Discharging the treated water into the Kalamazoo River would meet NPDES requirements, which would require the treatment of organics and inorganics to meet more stringent limits. Due to the larger number of metals being treated under this alternative, it is expected that this treatment would be performed more effectively by the precipitation/flocculation/sedimentation process.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; and, activated carbon adsorption to reduce the organic loading.

The treated water would then be discharged directly to the Kalamazoo River. The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

5.9 Alternative 9 - Groundwater Containment Via Low Flow Extraction/ Metals Treatment/ Filtration/Air Stripping/Activated Carbon Adsorption/ Discharge to the Kalamazoo River

This extraction, treatment, and off-site disposal alternative involves containing the impacted groundwater and eliminating any further migration by extracting impacted groundwater from the aquifer at a low flow rate, treating the extracted groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River. The intent of this alternative would be to contain the groundwater on site by depressing the water table.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II Remedial Design (RD) phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top or pilot scale treatability studies of ion exchange and precipitation/ sedimentation/flocculation processes.

This alternative is the same as Alternative seven, except air stripping has been added as the primary process for the removal of organics, and the activated carbon adsorption system is a polishing step.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; air stripping to remove the bulk of the organic loading; and, activated carbon adsorption as a polishing step.

The treated water would then be discharged directly to the Kalamazoo River. This alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

5.10 Alternative 10 - High Flow Groundwater Extraction/Metals Treatment/Filtration/Air Stripping/Activated Carbon Adsorption/ Discharge to the Kalamazoo River

This extraction, treatment, and off-site disposal alternative involves the extraction of the

impacted groundwater from the aquifer, treating the groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top or pilot scale treatability studies of ion exchange and precipitation/ sedimentation/flocculation processes.

This alternative is the same as Alternative eight, except air stripping has been added as the primary process for the removal of organics, and the activated carbon adsorption system is a polishing step.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; air stripping to remove the bulk of the organic loading; and, activated carbon adsorption as a polishing step.

The treated water would then be discharged directly to the Kalamazoo River. The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater

leaves the site and is recharged from the upgradient aquifer which is expected to flush the residual materials out of the groundwater system under natural conditions.

6.0 SCREENING OF ALTERNATIVES

This section screens the remedial alternatives developed in Section 5.0 based on effectiveness, implementability, and cost criteria. The purpose of the screening evaluation is to reduce the number of alternatives, where appropriate, to be carried through the detailed evaluation of alternatives. Comparisons between alternatives that are similar in terms of effectiveness, implementability and cost are usually made during screening, and the most promising alternatives are carried forward for further analysis. The three screening criteria are briefly described below:

Effectiveness: Each alternative is evaluated in terms of its effectiveness in protecting the public and the environment from the risks associated with the hazardous materials present at the site. This criteria includes an evaluation of the effectiveness of alternatives in reducing toxicity, mobility and volume through treatment and the time required to achieve the remedial objectives.

Implementability: Each alternative is evaluated in terms of the ability to construct and reliably operate the alternative, while meeting any technology or site-specific restrictions until the remedial action is complete. The evaluation includes administrative feasibility and the ability to obtain the equipment required for the alternatives.

Cost: Cost is used to evaluate and, where appropriate, reject similar alternatives which do not provide better effectiveness, implementability, or a greater degree of public health and environmental protection than other more cost effective alternatives.

The groundwater remedial alternatives are listed in Table 6-1.

Table 6-1

Auto Ion FS - OU II
Summary of Remedial Action Alternatives

Alternative 1 -	No Further Action
Alternative 2 -	Natural Attenuation/Institutional Controls
Alternative 3 -	Slurry Wall/Cap
Alternative 4 -	High Flow Groundwater Extraction/Discharge to Publicly Owned Treatment Works (POTW)
Alternative 5 -	Groundwater Containment Via Low Flow Extraction/Metals Treatment/Filtration/Discharge to a POTW
Alternative 6 -	High Flow Groundwater Extraction/Metals Treatment/Filtration/ Discharge to a POTW
Alternative 7 -	Groundwater Containment Via Low Flow Extraction/Metals Treatment/Filtration/Activated Carbon Adsorption/Discharge to the Kalamazoo River
Alternative 8 -	High Flow Groundwater Extraction/Metals Treatment/Filtration/ Activated Carbon Adsorption/Discharge to the Kalamazoo River
Alternative 9 -	Groundwater Containment Via Low Flow Extraction/Metals Treatment/Filtration/Air Stripping/Activated Carbon Adsorption/ Discharge to the Kalamazoo River
Alternative 10 -	High Flow Groundwater Extraction/Metals Treatment/Filtration/Air Stripping/Activated Carbon Adsorption Discharge to the Kalamazoo River

* Metals Treatment would mean either ion exchange or precipitation/ flocculation/sedimentation, based on the results of a bench top and/or pilot scale treatability study.

6.1 Alternative 1: No Further Action

Description: The No Further Action alternative is intended to be used as a baseline against which other alternatives may be compared. This alternative, as applied to Operable Unit II (OU II) of the Auto Ion site specifies that no additional remedial actions would be taken to remediate groundwater at the site.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

According to the Baseline Risk Assessment, no receptors will be adversely impacted during the period of natural attenuation of groundwater constituents at current concentrations. Existing institutional controls are expected to prevent the use of the groundwater during the time required for natural attenuation to occur.

Effectiveness: This alternative is protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. The only remaining source of groundwater contamination from the Auto Ion site will be resolved. The groundwater would be remediated by natural attenuation. Existing institutional controls can reasonably be assumed to remain in place over the period of time required for the groundwater to be remediated by natural attenuation.

Implementability: This alternative could be easily implemented.

Cost: There are no significant costs associated with the implementation of this alternative.

Conclusion: This alternative will be retained as a baseline for evaluating other alternatives.

6.2 Alternative 2: Natural Attenuation/Institutional Controls

Description: This alternative involves the continued periodic inspection and monitoring of the site, while the groundwater is allowed to naturally attenuate. Institutional controls that prevent the use of this groundwater are already in place. They include the state and county health department's restriction on the installation of wells in this area which includes Act 399, P.A., Michigan's Safe Drinking Water Act and the City of Kalamazoo's water supply system well site selection criteria and expansion plans. A copy of an application for installation of a water supply well is included in Appendix M. Additional redundant controls such as deed restrictions could also be used. The monitoring program would assure that the concentrations of the parameters of concern are decreasing. The monitoring program would be developed in the Remedial Design phase.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

According to the Baseline Risk Assessment, no receptors will be adversely impacted during the period of natural attenuation of groundwater constituents at current concentrations. Existing and/or augmented institutional controls are expected to prevent the use of the groundwater as a drinking water source during the time required for natural attenuation to occur.

Effectiveness: This alternative is protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. The source of groundwater contamination from the Auto Ion site will be eliminated. The groundwater would be remediated by natural attenuation. Existing institutional controls can reasonably be assumed to remain in place over the period of time required for the groundwater to be remediated by natural attenuation.

Groundwater monitoring and deed restriction during natural attenuation remediation would provide an extra backup measure to assure protection of public health, welfare and the environment.

Implementability: This alternative could be easily implemented.

Cost: The costs associated with the implementation of this alternative are minimal.

Conclusion: This alternative will be retained for detailed evaluation.

6.3 Alternative 3: Slurry Wall/Cap

Description: The alternative involves the containment of impacted groundwater by the construction of a slurry wall around the perimeter of the impacted groundwater. The slurry wall would be constructed of a soil/bentonite mixture and would be keyed into the confining layer existing approximately 110 feet below the ground surface. The objective of this alternative would be to contain any impacted groundwater and eliminate further migration. A cap would be used to minimize any infiltration of precipitation and runoff. The contained groundwater would not be extracted and treated. It may be necessary to monitor and adjust hydraulic levels within the containment structure to maintain its integrity.

This alternative would include a monitoring program to ensure that the impacted groundwater does not migrate from the containment area.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: A slurry wall/cap system, which encloses all the groundwater with chemical residuals exceeding remedial action objectives, would be effective in reducing the mobility of the impacted groundwater. Although this alternative would be protective of public health, welfare and the environment on a short-term basis, its long-term integrity is questionable and it relies on institutional controls as a permanent measure rather than improvement of groundwater quality as in the other alternatives. This alternative would prevent the remediation of the groundwater by natural attenuation.

Implementability: A bentonite slurry wall would have to be keyed into the confining layer below the site to be effective in containment. The depth of this confining layer is estimated at 110 feet below grade, which is at the upper limit of construction feasibility for a slurry wall system. Encircling all the affected groundwater may be difficult or impossible to implement due to existing structures such as roads and utilities.

Cost: The perimeter of the Auto Ion site is approximately 970 feet in length. With a depth to the confining layer estimated at 110 feet, the total surface area of a slurry wall would be at least 106,700 square feet. The surface of the site covers an area of 57,088 square feet. Based on current vendor quotation of approximately \$15 per square foot of wall and \$2.50 per square foot of cap, the cost of this alternative is estimated at over \$1,700,000. This does not include additional costs relating to moving utilities, gaining access to adjacent properties, if necessary, or the cost of dewatering and excavating soils adjacent to the river. These items would be expected to substantially increase the cost of this alternative.

Conclusion: This alternative relies on permanent institutional controls to restrict development. This alternative would use the extreme limits of slurry wall construction technology to obtain a depth of 110 feet; the structural integrity of the wall would be questionable. This alternative may be very difficult to implement due to existing structures (e.g., roads, utilities) which may need to be moved. The cost to implement this alternative is estimated to be higher than other alternatives which offer a greater degree of effectiveness and implementability. For these reasons, this alternative will be excluded from detailed evaluation.

6.4 Alternative 4: High Flow Groundwater Extraction/Discharge to POTW

Description: This extraction and POTW discharge alternative involves extracting the impacted groundwater at a high flow rate (10 to 30 gpm) from the aquifer and discharging it to a POTW. The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II Remedial Design phase. The extracted groundwater would be discharged through the sanitary sewer for treatment at the City of Kalamazoo's POTW.

This alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing. The discharge to the sanitary sewer would also be monitored to comply with any limits on the discharge to the POTW.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of

area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: This alternative would be protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. However, due to the presence of silt and clay contained in the sand within the shallow aquifer, this alternative is not expected to be capable of reducing groundwater constituents to MDNR Type B levels, if possible, substantially sooner than by natural attenuation. In short, the desorption rates of metals in clay and silt surface media, not the rate of groundwater flow, is the critical factor in determining the time required to improve groundwater quality. As fully explained in Appendix F, due to site geology and retardation factors, it may not be possible to achieve Type B levels using this or any other remedial alternative. Off-site contamination of groundwater from continuing sources may also impede any attempt to improve groundwater quality despite active pumping and treating of the groundwater.

Implementability: The technology for extracting the groundwater is readily available. The site is serviced by an existing sanitary sewer on O'Neil Street which is not part of a combined sewer system. Due to the proximity of the river, high flow extraction would result in the pumping of large volumes of river water, which may not be cost effective.

The City of Kalamazoo's POTW has indicated that they would accept the impacted groundwater without treatment, only if it meets their discharge limitations. Based on existing groundwater quality data, this direct discharge would be in violation of the City of Kalamazoo's Pretreatment Program and their discharge limitations (see Appendix G), issued to the City by the Michigan Department of Natural Resources (MDNR). The city's NPDES permit disallows the presence of mercury in their effluent or treatment residuals. The City of Kalamazoo's pretreatment program restricts the discharge of waste water containing detectable concentrations of mercury to the POTW. Although mercury may not be detectable in the extracted groundwater after Operable Unit I is implemented, for the purpose of this evaluation we assume that it may be present. In addition, two other inorganics (lead and nickel) currently present in the groundwater may exceed

the Daily Maximum Concentration Limits established by the City. It is possible that the City might grant a waiver of its requirements. This possibility will be considered in Alternatives 5 and 6. If a waiver is available, Alternatives 5 and 6 would essentially duplicate this alternative. Therefore, assuming a waiver of pretreatment requirements is not available, this Alternative does not appear to be feasible to implement.

Cost: The costs associated with the implementation of this alternative are expected to be substantially higher than those associated with Alternatives 1 and 2 (No Further Action and Natural Attenuation/Institutional Controls).

Conclusion: Assuming a pretreatment waiver is not available, this Alternative does not appear to be implementable. It will be excluded from detailed evaluation.

6.5 Alternative 5 - Groundwater Containment via Low Flow Extraction/Metals Treatment/Filtration/Discharge to POTW

Description: This extraction, pretreatment, and off-site disposal alternative involves containing the impacted groundwater and eliminating any further migration by extracting impacted groundwater from the aquifer at a low flow rate, pretreating the extracted groundwater using an on-site treatment system, and discharging the pretreated water to the sanitary sewer for treatment at the City of Kalamazoo's POTW. The intent of this alternative would be to contain the groundwater on site by depressing the water table.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II Remedial Design (RD) phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be determined during the OU II RD, and may require bench-top

and/or pilot scale treatability studies of ion exchange and precipitation/ sedimentation/flocculation and filtration processes.

Based on the expected quality of the extracted groundwater and preliminary information regarding the City's pretreatment requirements, some metals may preclude the direct discharge of extracted groundwater to the POTW. If it is determined that a waiver to pretreatment requirements can be obtained, or that an improvement in groundwater quality no longer requires pretreatment, direct discharge to the sanitary sewer would be implemented.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/sedimentation/flocculation process to remove inorganics; and filtration to reduce solids loading. The pretreated water would then be discharged directly to the POTW.

The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: This alternative would be protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. However, due to the presence of silt and clay contained in the sand within the shallow aquifer, this alternative is not expected to be capable of reducing groundwater constituents to MDNR Type B levels, if possible, substantially sooner than by natural attenuation. In short, the

desorption rates of metals in clay and silt surface media, not the rate of groundwater flow, is the critical factor in determining the time required to improve groundwater quality. As fully explained in Appendix F, due to site geology and retardation factors, it may not be possible to achieve Type B levels using this or any other remedial alternative. Off-site contamination of groundwater from continuing sources may also impede any attempt to improve groundwater quality despite active pumping and treating of the groundwater.

Implementability: This alternative is implementable. The technology for extracting the groundwater is readily available. Precipitation/sedimentation/flocculation and filtration processes are well accepted pretreatment technologies for the removal of inorganics. Based on the available groundwater quality data, the expected organic loading would be below the City's Discharge Limitations without pretreatment. The existing sanitary sewer on O'Neil Street is not part of a combined sewer system. Due to the proximity of the river, high flow extraction would result in the pumping of large volumes of river water, which may not be cost effective.

Cost: An extraction and on-site treatment system would involve a capital expenditure for construction, along with ongoing operation and maintenance costs. The cost of this alternative is significantly higher than Alternatives 1 and 2, however, treatment at the POTW is nominal in comparison with treatment to a level for direct discharge to the river (a copy of the City of Kalamazoo's sewer ordinance including their rate structure, is in Appendix H). The estimated flow rate necessary to contain the impacted groundwater is estimated at approximately 5 to 20 gallons per minute (gpm).

Conclusion: This alternative will be retained for detailed evaluation.

6.6 Alternative 6: High Flow Groundwater Extraction/Metals Treatment/Filtration/ Discharge to POTW

Description: This extraction, pretreatment, and off-site disposal alternative involves actively remediating the aquifer by extracting the groundwater from the impacted saturated zone of the

aquifer at a high flow rate (10 to 30 gpm), pretreating the extracted groundwater using an on-site treatment system, and discharging the pretreated water to the sanitary sewer for treatment at the City of Kalamazoo's POTW. The intent of this alternative would be to more vigorously actively restore the aquifer by pumping and treating the impacted groundwater.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be determined during the OU II RD, and may require bench-top and/or pilot scale treatability studies of ion exchange and precipitation/ sedimentation/flocculation and filtration processes.

Based on the expected quality of the extracted groundwater and preliminary information regarding the City's pretreatment requirements, only a few specific metals may preclude the direct discharge of extracted groundwater to the POTW. If it is determined that a waiver to pretreatment requirements can be obtained, or that an improvement in groundwater quality no longer requires pretreatment, direct discharge to the sanitary sewer would be implemented.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/sedimentation/flocculation process to remove inorganics; and filtration to reduce solids loading. The pretreated water would then be discharged directly to the POTW.

The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: This alternative would be protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. However, due to the presence of silt and clay contained in the sand within the shallow aquifer, this alternative is not expected to be capable of reducing groundwater constituents to MDNR Type B levels, if possible, substantially sooner than by natural attenuation. In short, the desorption rates of metals in clay and silt surface media, not the rate of groundwater flow, is the critical factor in determining the time required to improve groundwater quality. As fully explained in Appendix F, due to site geology and retardation factors, it may not be possible to achieve Type B levels using this or any other remedial alternative. Off-site contamination of groundwater from continuing sources may also impede any attempt to improve groundwater quality despite active pumping and treating of the groundwater.

Implementability: This alternative is implementable. The technology for extracting the groundwater is readily available. Precipitation/sedimentation/flocculation and filtration processes are well accepted pretreatment technologies for the removal of inorganics. Based on the available groundwater quality data, the expected organic loading would be below the City's Discharge Limitations without pretreatment. The existing sanitary sewer on O'Neil Street is not part of a combined sewer system. Due to the proximity of the river, high flow extraction would result in the pumping of large volumes of river water, which may not be cost effective.

Cost: An extraction and on-site pretreatment system would involve a capital expenditure for construction, along with ongoing operation and maintenance costs. The expected flow rate required to contain the impacted groundwater is approximately 10 to 30 gallons per minute (gpm). The cost of this alternative is significantly higher than Alternatives 1 and 2, however, treatment at the POTW is nominal in comparison with treatment to a level for direct discharge to the river.

Conclusion: This alternative will be retained for detailed evaluation.

6.7 Alternative 7: Groundwater Containment Via Low Flow Extraction/Metals Treatment/ Filtration/Activated Carbon Adsorption/Discharge to the Kalamazoo River

Description: This extraction, treatment, and off-site disposal alternative involves containing the impacted groundwater and eliminating any further migration by extracting impacted groundwater from the aquifer at a low flow rate, treating the groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River. The intent of this alternative would be to contain the groundwater on-site by depressing the water table.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top and/or pilot scale treatability studies of ion exchange and precipitation/ sedimentation/flocculation processes.

The effluent would be discharged directly into the Kalamazoo River and would meet National Pollution Discharge Elimination System (NPDES) requirements. Based on the expected quality of the extracted groundwater and preliminary information from the MDNR regarding

NPDES discharge limitations, a number of the metals would have to be reduced in concentration before discharging to the river. Based on experience in similar applications, the appropriate metals treatment for this alternative would be precipitation/ flocculation/sedimentation.

Organic compounds would be removed by activated carbon adsorption. The organic compounds present at the site can meet NPDES requirements with this technology.

This alternative differs from Alternative 5 due to level of treatment required and where the effluent is discharged. The treated water discharged into the Kalamazoo River would need to meet NPDES requirements, which would require the treatment of organics and inorganics to meet more stringent limits. Due to the larger number of metals being treated under this alternative, it is expected that this treatment would be performed more effectively by the precipitation/flocculation/sedimentation process.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; and, activated carbon adsorption to reduce the organic loading.

The treated water would then be discharged directly to the Kalamazoo River. The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: This alternative is protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. The effectiveness of this alternative is identical to Alternative 5 (Groundwater Containment via Low Flow Extraction/Metals Treatment/Filtration/Discharge to a POTW).

Implementability: This alternative is implementable. The technology is readily available for extracting the ground water. Precipitation/sedimentation/flocculation and filtration processes are well accepted technologies the removal of inorganics. Activated carbon adsorption is used routinely for the reducing the organic loading in aqueous waste streams. NPDES discharge limitations should be met. Due to the proximity of the river, high flow extraction would result in the pumping of large volumes of river water, which may not be cost effective.

Cost: The cost of this alternative would be substantially higher than Alternative 5 due to the greater level of treatment required for inorganics and organics to meet NPDES limits.

Conclusion: Alternative 5 provides the same degree of effectiveness and implementability at substantially lower cost Therefore, this alternative will be excluded from detailed evaluation.

6.8 Alternative 8: High Flow Groundwater Extraction/Metals Treatment/Filtration/ Activated Carbon Adsorption/Discharge to the Kalamazoo River

Description: This extraction, treatment, and off-site disposal alternative involves actively remediating the aquifer by extracting the groundwater from the impacted saturated zone of the aquifer at a high flow rate, treating the extracted groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River. The intent of this alternative would be to more vigorously actively restore the aquifer by pumping and treating the impacted groundwater.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top and/or pilot scale treatability studies of ion exchange and precipitation/sedimentation/flocculation processes.

The effluent would be discharged directly into the Kalamazoo River and would meet National Pollution Discharge Elimination System (NPDES) requirements. Based on the expected quality of the extracted groundwater and preliminary information from the MDNR regarding NPDES discharge limitations, a number of the metals would have to be reduced in concentration before discharging to the river. Based on experience in similar applications, the appropriate metals treatment for this alternative would be precipitation/flocculation/sedimentation.

Organic compounds would be removed by activated carbon adsorption. The organic compounds present at the site can meet NPDES requirements with this technology.

This alternative differs from Alternative 6 due to level of treatment required and where the effluent is discharged. The treated water discharged into the Kalamazoo River would need to meet NPDES requirements, which would require the treatment of organics and inorganics to meet more stringent limits. Due to the larger number of metals being treated under this alternative, it is expected that this treatment would be performed more effectively by the precipitation/flocculation/sedimentation process.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; and, activated carbon adsorption to reduce the organic loading.

The treated water would then be discharged directly to the Kalamazoo River. The alternative would also involve a monitoring program to ensure that the impacted groundwater does

not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: This alternative would be protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. The effectiveness of this alternative is identical to Alternative 6 (High Flow Groundwater Extraction/Metals Treatment/Filtration/Discharge to a POTW).

Implementability: This alternative is implementable. The technology is readily available for extracting the ground water. Precipitation/sedimentation/flocculation and filtration processes are well accepted technologies the removal of inorganics. Activated carbon adsorption is used routinely for the reducing the organic loading in aqueous waste streams. NPDES discharge limitations should be met. Due to the proximity of the river, high flow extraction would result in the pumping of large volumes of river water, which may not be cost effective.

Cost: The cost of this alternative would be substantially higher than Alternative 6 due to the greater level of treatment required for inorganics and organics necessary to meet NPDES limits.

Conclusion: Alternative 6 provides the same degree of effectiveness and implementability at a substantially lower cost. Therefore, this alternative will be excluded from detailed evaluation.

**6.9 Alternative 9: Groundwater Containment Via Low Flow Extraction/Metals Treatment/
Filtration/Air Stripping/Activated Carbon Adsorption/Discharge to the Kalamazoo River**

Description: This extraction, treatment, and off-site disposal alternative involves containing the impacted groundwater and eliminating any further migration by extracting impacted groundwater from the aquifer at a low flow rate, treating the extracted groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River. The intent of this alternative would be to contain the groundwater on-site by depressing the water table.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II Remedial Design (RD) phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top or pilot scale treatability studies of ion exchange and precipitation/sedimentation/ flocculation processes.

This alternative is the same as Alternative 7 except air stripping has been added as the primary process for the removal of organics, and the activated carbon adsorption system is a polishing step.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; air stripping to remove the bulk of the organic loading; and, activated carbon adsorption as a polishing step.

The treated water would then be discharged directly to the Kalamazoo River. This alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: This alternative would be protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. The effectiveness of this alternative is identical to Alternative 5 (Groundwater Containment via Low Flow Extraction/Metals Treatment/Filtration/Discharge to a POTW).

Implementability: This alternative is implementable. The technology is readily available for extracting the groundwater. Precipitation/sedimentation/flocculation and filtration processes are well accepted technologies for the removal of inorganics. Air stripping is routinely used to remove volatile organics from aqueous waste streams. Vapor phase and liquid phase carbon is commonly used as a polishing step and the associated equipment is readily available. NPDES discharge limitations should be easily met. Due to the proximity of the river, high flow extraction would result in the pumping of large volumes of river water, which may not be cost effective.

Cost: The cost of this alternative would be substantially higher than Alternative 5 due to the greater level of treatment required for inorganics and organics necessary to meet NPDES limits.

Conclusion: Alternative 5 provides the same degree of effectiveness and implementability at a substantially lower cost. Therefore, this alternative will be excluded from detailed evaluation.

6.10 Alternative 10: High Flow Groundwater Extraction/Metals Treatment/Filtration/Air Stripping/Activated Carbon Adsorption/Discharge to the Kalamazoo River

Description: This extraction, treatment, and off-site disposal alternative involves the extraction of the impacted groundwater from the aquifer, treating the groundwater using an on-site treatment system, and discharging the treated water to the Kalamazoo River.

The groundwater would be extracted by a system using a combination of extraction wells, subsurface drains, and/or hanging walls. The design of this system would be based on additional hydrogeological data obtained during the OU II RD phase.

A treatment system would be designed and constructed or assembled on-site. The final metals treatment process would be based on the results of a design which may require bench-top or pilot scale treatability studies of ion exchange and precipitation/sedimentation/flocculation processes.

This alternative is the same as Alternative 8 except air stripping has been added as the primary process for the removal of organics, and the activated carbon adsorption system is a polishing step.

For the purposes of evaluating this alternative, the particular treatment units to include are: a precipitation/flocculation/sedimentation process to remove inorganics; filtration to reduce solids loading; air stripping to remove the bulk of the organic loading; and, activated carbon adsorption as a polishing step.

The treated water would then be discharged directly to the Kalamazoo River. The alternative would also involve a monitoring program to ensure that the impacted groundwater does not migrate from the controlled area and that the concentrations of parameters of concern are decreasing.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the cleanup of all

materials left on the surface of the site. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils, which will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site. The impacted groundwater is expected to decrease in both concentration of constituents and extent of area affected as the groundwater leaves the site and is recharged from the upgradient aquifer through natural attenuation.

Effectiveness: This alternative would be protective of public health, welfare and the environment given that no receptors are currently being adversely impacted by groundwater at the site. The effectiveness of this alternative is identical to Alternative 6 (High Flow Groundwater Extraction/Metals Treatment/Filtration/Discharge to a POTW).

Implementability: This alternative is implementable. The technology is readily available for extracting the groundwater. Precipitation/sedimentation/flocculation and filtration processes are well accepted technologies for the removal of inorganics. Air stripping is routinely used to remove volatile organics from aqueous waste streams. Vapor phase and liquid phase carbon is commonly used as a polishing step and the associated equipment is readily available. NPDES discharge limitations should be met. Due to the proximity of the river, high flow extraction would result in the pumping of large volumes of river water, which may not be cost effective.

Cost: The cost of this alternative would be substantially higher than Alternative 6 due to the greater level of treatment required for inorganics and organics necessary to meet NPDES limits.

Conclusion: Alternative 6 provides the same degree of effectiveness and implementability at a substantially lower cost. Therefore, this alternative will be excluded from detailed evaluation.

6.11 Summary

Alternative 1 (No Further Action), Alternative 2 (Natural Attenuation/Institutional Controls), Alternative 5 (Groundwater Containment via Low Flow Extraction/Metals Treatment/Filtration/Discharge to a POTW) and Alternative 6 (High Flow Groundwater Extraction/Metals Treatment/Filtration/Discharge to a POTW) were retained for detailed evaluation.

Alternative 3 (Slurry Wall/Cap) was excluded from further evaluation due to poor effectiveness, implementability and cost.

Alternative 4 (High Flow Groundwater Extraction/Discharge to POTW) was excluded from further evaluation due to poor implementability.

Alternatives 7, 8, 9 and 10 all involved variations of extraction of groundwater, on-site treatment and discharge to the Kalamazoo River. All of these alternatives were excluded from further evaluation due to higher cost without improved effectiveness or implementability compared to Alternatives 5 and 6.

7.0 Detailed Analysis of Alternatives

7.1 Introduction

Remedial action alternatives that were developed and retained based on the Screening of Alternatives Section (Section 6.0) are described and evaluated in detail in this section. Each alternative is assessed in terms of CERCLA compliance.

USEPA incorporated the SARA 121(b) criteria into nine evaluation criteria presented in the National Oil and Hazardous Substances Pollution Contingency Plan (NCP, Part 300.430) and as required by the NCP, each remedial alternative is assessed against the nine criteria in this section. The NCP evaluation criteria are summarized as follows:

Overall Protection of Human Health and the Environment - The degree to which unacceptable site risks identified in the Remedial Investigation Baseline Risk Assessment are eliminated, reduced or controlled by the remedial alternative.

Compliance with ARARs - Whether requirements that are applicable or relevant and appropriate to a given alternative are satisfied by the alternative or whether there is sufficient justification for a waiver.

Long-Term Effectiveness and Permanence - The magnitude of risk remaining after remedial activities are complete. Potential risks relate to untreated hazardous substances or treatment residuals and the ability of planned controls to provide sufficient protection from these potential hazards.

Reduction of Toxicity, Mobility or Volume through Treatment - The ability of the alternative to reduce toxicity of hazardous substances, reduce the total mass or volume of hazardous substances and/or the mobility of hazardous substances.

Short-Term Effectiveness - The human health and environmental impacts during implementation including the need to protect the community and workers during the remedial action, environmental impacts during implementation and the time required to achieve the remedial action objectives.

Implementability - The technical and administrative feasibility of implementing an alternative including the reliability of the technology, identification of any anticipated difficulties in construction and/or operation of the technology, and the ability to monitor the effectiveness of the remedy.

Cost - The capital cost, annual operation and maintenance cost, and present worth of the alternative. Capital costs include expenditures for the equipment, labor, materials, transportation and disposal necessary to implement the remedial actions, as well as expenditures for engineering, legal, financial and other necessary services. Annual operation and maintenance (O&M) is required to ensure the continued effectiveness of a remedial action, and O&M costs include maintenance, materials, labor, disposal, energy costs, insurance, taxes, licensing and administrative costs. The present worth analysis discounts all future costs to a common year, usually the current year.

State Acceptance - The technical and administrative concerns the State may have regarding the alternative.

Community Acceptance - Public concerns regarding the alternatives.

Note: The State and Community Acceptance criteria will be addressed after the RI/FS report and proposed remediation plan has been reviewed by the public.

7.2 Overview of Remedial Action Objectives

Remedial action objectives (RAOs) are defined in Section 3.2. The CERCLA Baseline Risk Assessment did not identify any adversely impacted receptors from groundwater at current concentrations. The RAOs were determined to be compliance with ARARs. At this site the RAOs would be met by compliance with Michigan Act 307. Under Act 307, it is possible to use either Type B cleanup criteria (non site-specific) or Type C cleanup criteria (site-specific).

7.3 Groundwater Modeling Summary

Documentation of groundwater modeling to determine the estimated flow rates necessary for groundwater extraction alternatives and to estimate the time required to implement each groundwater alternative is contained in Appendices I and F, respectively.

Modeling of potential extraction flow rates ranged from approximately 5 gpm to 30 gpm. The actual flow rate required for a groundwater extraction alternative can only be estimated as a range at this time. The exact flow rates would require additional hydrogeological data (e.g. vertical and horizontal hydraulic conductivities) that is currently unavailable. This data could be obtained during the remedial design (RD) phase. For cost estimation purposes both ends of extraction flow rates were used in this FS. However, the high end of the flow rate range was used in order to avoid underestimating costs in comparisons between alternatives.

Groundwater modeling to determine completion time frames for the alternatives was conducted and is contained in Appendix F. Nickel was used as an indicator of the length of time required for groundwater quality to improve to MDNR Type B levels, if attainable. Nickel was selected since it represents 50% of the non-carcinogenic drinking water risk, it is characteristic of groundwater constituents which would be difficult to remove from the aquifer, and because of the availability of soil sorption data.

The calculated cleanup time frames were determined by using a one-dimensional solute transport model entitled "POLLUTE". In order to assess the sorption/desorption of nickel with respect to the site soil materials, data developed by Bowman, et al. (1981) was utilized. Bowman's research provided information with respect to the sorption characteristics of nickel onto various types of soil materials. For the purposes of this analysis, it is assumed that desorption of nickel would take place at the same rate as the sorption process. This is an extremely conservative assumption, because normally the desorption process takes longer than the sorption process (see Appendix F).

The flushing of chemicals (nickel) was considered for the total width of the site, from O'Neil Street to the river. Thus, the time frame to flush nickel from the subsurface over this length of approximately 250 feet was calculated.

The first set of calculations in Appendix F assumed that the aquifer soil materials was a sand. Under these conditions, it was calculated it would take approximately 30 to 35 years for groundwater flow to flush the nickel from the subsurface soils across the entire site area. If an active remedial program were employed, the time frame to achieve removal of nickel from the site area is calculated to be in the range of 10 to 15 years. (For all of these evaluations, the site was considered cleaned-up when nickel was reduced to a groundwater concentration of 100 micrograms per liter.)

However, the assumption that the aquifer is composed completely of a sand material is not realistic. The aquifer soils are a mixture of sand, silt and clay with traces of some gravel. The finer grained silt and clay is mixed with the sand, occurs as interbeds in the sand, and as lenses up to 10 feet thick. This description is based upon numerous grain-sized analyses conducted on soil samples taken from the site, the boring log information and based on the characteristics of this type of geological formation. The presence of silt/clay lenses in the aquifer soil will retard the movement of chemicals such as nickel across the site area. The retardation will lengthen the cleanup time frame.

An assessment of the rate of desorption of nickel from silt/clay soils was made, and it was found that cleanup times were in the range of 50 to 60 years for a natural flushing system as well as for a remedial pumping system. The silt/clay content of the aquifer soils was estimated at approximately 10%. Generally, the presence of silt and clay material in the aquifer soils provides a medium that significantly retards the removal of chemicals such as nickel and increases the term of the cleanup process. The retardation of the chemicals is such that these chemicals will slowly bleed out of the silt and clay layer. Even if the sand is pumped at a very fast rate, the critical factor is the rate at which chemicals such as nickel will bleed from the silt/clay. Thus, even though the sand lens may tend to cleanup faster than the silt/clay material, the chemicals in the silt/clay material, and the rate at which these chemicals dissipate, are the critical factor with respect to site cleanup time requirements. It is also noted that the other chemicals, such as VOCs, may require less time to desorb from the aquifer soil materials as compared to nickel.

Therefore, it appears that all of the alternatives examined would require essentially the same time period, estimated at 50 to 60 years, to potentially attain MDNR Type B cleanup levels. It is important to note that high retardation factors of certain constituents may, in fact, inhibit any of the remedial alternatives evaluated in this section from ever fully meeting Michigan Act 307 Type B cleanup criteria. Regardless of the alternative (e.g. natural attenuation or active groundwater extraction) an asymptotic point of improved groundwater quality may be reached. At that point it would be virtually impossible to further improve groundwater quality regardless of the type of extraction (e.g. natural or mechanical) used.

7.4 Individual Analysis of Alternatives

This section presents a detailed analysis of the groundwater remedial alternatives. These alternatives only address groundwater at the site, since source remediation of impacted soils has already been addressed under Operable Unit I.

7.4.1 Alternative 1 - No Further Action

7.4.1.1 Description of Alternative 1

The No Further Action Alternative provides a baseline against which other alternatives may be compared. This alternative would involve no additional remedial actions being undertaken to remediate impacted groundwater at the site.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the removal of all materials left on the surface of the site that could have been a source of groundwater contamination. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils. This will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site.

This alternative includes existing natural processes of groundwater remediation. In the absence of any off-site sources, natural attenuation is expected to substantially improve groundwater quality over time. The hydrogeological assessment of the site in the Remedial Investigation (RI) determined that the groundwater at the site discharges into the adjacent Kalamazoo River. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer.

It is estimated that it would take approximately 50 to 60 years for natural attenuation to potentially achieve MDNR Type B cleanup levels (see Appendix F). It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternative due to site geology and the retardation factors of some groundwater constituents. MDNR Type C cleanup levels are already being met as explained in Appendix J. The average rate of groundwater discharging from the site is approximately 3.5 gpm.

Under natural conditions, it is estimated that one pore volume of groundwater is discharged approximately every 5 years.

This alternative includes existing institutional controls which would prevent the groundwater from being used as a water source over which time natural attenuation is expected to substantially improve groundwater quality. City water is already supplied to this area and the installation of new wells is restricted by the state and county health departments. Only the City of Kalamazoo would be able to obtain a permit to install a well in this area in the event that it needed to expand groundwater production for the current water supply system. The city uses a series of criteria to select new well sites. The first criteria is the absence of any potential source of groundwater contamination in the area, which includes a review of all industrial facilities, CERCLA, and state superfund sites. The City would not develop the groundwater in this area due to adjacent sites of known contamination, the presence of active industrial facilities and the elevated concentrations of sodium, even if the Auto Ion site were not present. All future expansion plans for wells by the city water department are in the outlying township areas, away from the city where the site is located. The State of Michigan also restricts the installation of drinking water wells within the 100 year floodplain. Any drinking water well must have a sloping ground surface, at least 50' in diameter, away from the well and above the 100 year floodplain. The Auto Ion site is in the 100 year floodplain. Additionally, after five years, the site would be evaluated by USEPA pursuant to CERCLA Section 121(c) to assure that no further remedial action is warranted.

7.4.1.2 Assessment of Alternative 1

Overall Protection of Human Health and the Environment - This alternative is protective of human health and the environment given that no receptors are currently being adversely impacted by groundwater at the site. Specifically, the CERCLA Baseline Risk Assessment did not identify any impact from the groundwater concentrations currently discharging to the river. Also, as concluded in the March 1993 Sediment Toxicity Evaluation Report, there

would not be a measurable effect on water quality due to the large flow in the river as compared to the groundwater flux to the river. The results of the evaluation also supports a similar conclusion that there is not discernible impact on the aquatic macroinvertebrate community of the Kalamazoo River. The only possibility of adversely impacting a receptor in the future would be if impacted groundwater were used as a drinking water source. It was determined that site specific conditions made this potential extremely unlikely (see Baseline Risk Assessment). Existing institutional controls would restrict the use of the groundwater as a drinking water source for the foreseeable future during which time natural attenuation is expected to substantially improve groundwater quality.

Compliance with ARARs - This alternative would not comply with all ARARs as described below. Potential chemical-specific, location-specific and action-specific ARARs were identified in Section 2 of this report.

Chemical specific ARARs for this alternative include the Michigan Environmental Response Act (Act 307), RCRA Groundwater Protection Standards and Michigan Water Quality Standards. This alternative would not immediately meet Act 307 requirements as a Type B cleanup, but may do so in the future. This alternative would immediately meet Act 307 requirements as a Type C cleanup, as documented in Appendix J. RCRA Groundwater Protection Standards would not be met since requirements for establishing Alternative Concentration Limits (ACLs) and monitoring would not be undertaken as part of the No Action Alternative. Michigan Water Quality Standards would be met since modeling in the Baseline Risk Assessment determined that no measurable impact to surface water quality would be caused by the groundwater discharge.

No location-specific ARARs would apply to this alternative since no use or development of the site property would be undertaken.

No action-specific ARARs would apply to this alternative since no actions would be undertaken.

Long-Term Effectiveness and Permanence - Although this alternative is a baseline for comparison purposes, site-specific groundwater conditions are already protective of human health and the environment based on the CERCLA Baseline Risk Assessment of current groundwater concentrations. These site specific conditions include other source control response actions and natural attenuation of the groundwater. Even if no further remedial action is taken, natural attenuation of groundwater constituents would result in concentrations not unlike those found in the site vicinity given a sufficient period of time for attenuation to occur. Existing institutional controls are more than adequate to assure the groundwater would not be used as a water source in the foreseeable future. Even without the existence of these controls, the probability of this groundwater being used in the foreseeable future would be extremely remote since city water is supplied to the site and surrounding area. CERCLA's requirement to re-evaluate site conditions at subsequent five year intervals in the future would also assure that completion of natural attenuation would be documented.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Natural attenuation would result in a reduction of toxicity, mobility and volume through an improvement in the quality of groundwater, but not by using active treatment.

Natural attenuation would include natural biodegradation of organic constituents. The organic constituents present (VOCs) are subject to natural biodegradation which could result in the elimination (reduction of toxicity, mobility and volume) of these compounds over time. The period of time required for this natural process to occur is currently unknown. In Section 1.2.4.2 of this report, parent and biological breakdown products of chlorinated VOCs were identified in the groundwater as evidence of the occurrence of this process. It appears that concentrations of breakdown products have been increasing as parent compound concentrations decrease over time. Nevertheless, several chlorinated hydrocarbons present are known to be resistant to biodegradation; thus it is unlikely that all organic compounds present would be degraded.

Natural attenuation would remove inorganic analytes and recalcitrant organic compounds from groundwater and result in decreasing them by orders of magnitude below hazardous concentrations, reducing toxicity. The mobility and volume of these dilute constituents would be of no environmental concern, since they would not cause any adverse environmental impact.

In summary, the impacted groundwater is expected to dissipate and/or degrade over time due to natural attenuation. Although this is not an artificial treatment process, the toxicity, mobility and volume of the impacted groundwater is expected to be eliminated. This natural process will not have any significant adverse impacts on human health and the environment from current groundwater concentrations as discussed in the CERCLA Baseline Risk Assessment.

Short-Term Effectiveness - There would be no adversely impacted receptors during implementation. Existing institutional controls and site specific conditions are adequate to restrict any potential development of groundwater as a drinking water source during the remedial time frame as previously discussed in this section. No adverse environmental impacts would occur. It is estimated that it would take approximately 50 to 60 years for natural attenuation to potentially achieve MDNR Type B cleanup levels (see Appendix F). It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternative due to site geology and the retardation factors of some of the groundwater constituents. MDNR Type C cleanup levels are already being met as documented in Appendix J.

Implementability - This alternative is easily implementable since it requires no further action.

Cost - There are no costs associated with this alternative since it involves no further action.

7.4.2 Alternative 2 - Natural Attenuation/Institutional Controls

7.4.2.1 Description of Alternative 2

This alternative involves the continued periodic inspection and monitoring of the site, while the impacted groundwater is allowed to naturally attenuate and includes institutional controls and other source control remedial actions. The hydrogeological assessment of the site in the RI determined that the groundwater at the site discharges into the adjacent Kalamazoo River. The limited extent of impacted groundwater is expected to decrease in concentration as the groundwater leaves the site and is recharged from the upgradient aquifer. This alternative already meets RAOs for a Michigan Act 307 Type C cleanup, as documented in Appendix K. In the absence of any off-site sources, natural attenuation of impacted groundwater may eventually achieve concentrations which meet Michigan Act 307 Type B cleanup criteria, although this can not be determined with certainty at this time.

It is estimated that it would take approximately 50 to 60 years for natural attenuation to potentially achieve MDNR Type B cleanup levels (see Appendix F). It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternative due to site geology and the retardation factors of some of the groundwater constituents. MDNR Type C cleanup levels are already being met, as documented in Appendix K. The average rate of groundwater discharging from the site is approximately 3.5 gpm. Under natural conditions, it is estimated that one pore volume of groundwater is discharged approximately every 5 years.

As part of the Remedial Design (RD), ACLs would be developed consistent with RCRA guidance to be used as action levels for monitoring groundwater discharging from the site into the Kalamazoo River. The ACL application would be developed based on existing information and monitoring data obtained over the first year of groundwater monitoring. The ACL application would address each of the criteria specified in CFR Section 264.94(3)(b) of RCRA as stated below:

"(b) The Regional Administrator will establish an alternate concentration limit for a hazardous constituent if he finds that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded. In establishing alternate concentration limits, the Regional Administrator will consider the following factors:

- (1) Potential adverse effects on groundwater quality, considering:
 - (i) The physical and chemical characteristics of the waste in the regulated unit, including its potential for migration;
 - (ii) The hydrogeological characteristics of the facility and surrounding land;
 - (iii) The quantity of groundwater and the direction of groundwater flow;
 - (iv) The proximity and withdrawal rates of groundwater users;
 - (v) The current and futures uses of groundwater in the area;
 - (vi) The existing quality of groundwater, including other sources of contamination and their cumulative impact on the groundwater quality;
 - (vii) The potential for health risks caused by human exposure to waste constituents;
 - (viii) The potential damage to wildlife, crops, vegetation and physical structures caused by exposure to waste constituents;

- (ix) The persistence and permanence of the potential adverse effects; and,
- (2) Potential adverse effects on hydraulically-connected surface water quality, considering:
 - (i) The volume and physical and chemical characteristics of the waste in the regulated unit;
 - (ii) The hydrogeological characteristics of the facility and surrounding land;
 - (iii) The quantity and quality of groundwater and the direction of groundwater flow;
 - (iv) The patterns of rainfall in the region;
 - (v) The proximity of the regulated unit to surface waters;
 - (vi) The current and future uses of surface waters in the area and any water quality standards established for those surface waters;
 - (vii) The existing quality of surface water, including other sources of contamination and the cumulative impact on surface water quality;
 - (viii) The potential for health risks caused by human exposure to waste constituents;
 - (ix) The potential damage to wildlife, crops, vegetation and physical structures caused by exposure to waste constituents; and,
 - (x) The persistence and permanence of the potential adverse effects."

Ecological impact would be evaluated, as appropriate, as part of the development of ACLs. The ACL criteria should be met since the CERCLA Baseline Risk Assessment showed no impact from current groundwater concentrations discharging into the river.

An annual groundwater monitoring program would be developed in compliance with RCRA ACL guidance. This monitoring program would remain in effect for five years or until an asymptotic point of groundwater quality improvement is reached. The monitoring program will include a Remedial Action Plan evaluation process, in the event ACLs are exceeded during the monitoring period. This evaluation process will provide evaluation of all data gathered to date, and potential groundwater remediation alternatives. Details of the Remedial Action Plan will be outlined in the Design Report for OUII. Due to the potential unknown site conditions, a remedial action(s) can not be committed to at this time. After five years, a review would be undertaken by USEPA pursuant to CERCLA Section 121(c) to determine if further remedial action is warranted. The groundwater monitoring program would involve quarterly sampling of the groundwater and river during the first year and semi-annual sampling in subsequent years. During the first year, groundwater elevations from all wells and the river would be measured at least once a month. The elevation in selected wells would be measured continuously with remote chart recorders in order to better define groundwater flow conditions. Approximately three new monitoring wells would be installed and all wells would be sampled for constituents previously identified in the groundwater. The new monitoring wells would assist in determining background groundwater quality. As part of the annual monitoring program a review of area groundwater use would be conducted to assure that institutional controls remained in place and that no wells had been or were planned to be installed where they could be impacted from site groundwater. This monitoring program will be scheduled to start in September 1993 upon completion of the Operable unit I Remedial Action.

This alternative includes existing and additional institutional controls which would prevent the groundwater from being used. City water is already supplied to this area and the installation of new wells is restricted by the state and county health departments. Only

the City of Kalamazoo would be able to obtain a permit to install a well in this area in the event that it needed to expand groundwater production for the current water supply system. The city uses a series of criteria to select new well sites. The first criterion is the absence of any potential source of groundwater contamination in the area, which includes a review of all industrial facilities, CERCLA, and state superfund sites. The City would not develop the groundwater in this area due to other adjacent sites of known contamination, the presence of active industrial facilities and the elevated concentrations of sodium, even if the Auto Ion site were not present. All future expansion plans for wells by the city water department are in the outlying township areas, away from the city where the site is located. The State of Michigan also restricts the installation of drinking water wells within the 100 year floodplain. Any drinking water well must have a sloping ground surface, at least 50' in diameter, away from the well and above the 100 year floodplain. The Auto Ion site is in the 100 year floodplain. A permit application (Appendix M) would also be required prior to any well installation. This allows for County and State health department review and approval. The review process would be as outlined in Act 399, P.A., Michigan Safe Drinking Water Act.

A deed restriction would be placed on the site property as an additional redundant control mechanism to prevent the use of the impacted groundwater.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the removal of all materials left on the surface of the site that could have been a source of groundwater contamination. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils. This will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site.

As discussed in Section 1.3 of this report, there may be multiple off-site continuing sources of groundwater contamination which could also inhibit this alternative from ever achieving an Act 307 Type B cleanup.

The Preamble to the NCP discusses the appropriateness of using remedial actions involving natural attenuation and institutional controls like those identified in this alternative. The Preamble states that response actions which recognize the affects of natural attenuation, though increasing the time until RAOs are met, are acceptable if no receptors are being substantially adversely impacted. See 55 Federal Register 8734 (Thursday, March 8, 1990). Based on the CERCLA Baseline Risk Assessment, no groundwater receptors, including the river, are being adversely impacted at the Auto Ion site from current groundwater concentrations. Under the groundwater policy section of the Preamble, USEPA states that natural attenuation is an acceptable remedial alternative for groundwater under certain site specific conditions; it states:

Natural attenuation is generally recommended only when active restoration is not practicable, cost-effective or warranted because of site specific conditions (e.g. Class III ground water or ground water which is unlikely to be used in the foreseeable future and therefore can be remediated over an extended period of time)... See 55 Federal Register 8734 (Thursday, March 8, 1990).

Clearly, it is highly unlikely that impacted groundwater at the Auto Ion site will be used in the foreseeable future. According to the Preamble, the basis for USEPA's preference for active remediation over institutional controls is because institutional controls may not last forever and may not be permanent and therefore, may not provide an equivalent level of protection. See 55 Federal Register 8706 (Thursday, March 8, 1990). It is important to note that this alternative uses institutional controls only as a temporary control during which natural attenuation may be capable of achieving a Michigan Act 307 Type B cleanup. Moreover, modeling studies indicate that, as compared to natural attenuation, active remediation will not shorten the period of time in which Type B cleanup criteria may, if possible, be met (see Appendix F). The groundwater at this site already meets Michigan Act 307 Type C cleanup criteria since it limits exposure to groundwater doesn't allow exposures greater than 1.0×10^{-6} or a hazard ratio of 1, and assures adequate protection of surface water. It is reasonable to assume that the institutional controls used in this alternative will remain in place for many years over which time natural attenuation is expected to substantially improve groundwater quality.

7.4.2.2 Assessment of Alternative 2

Overall Protection of Human Health and the Environment - This alternative is protective of human health and the environment given that no receptors are currently being adversely impacted by groundwater at the site. Specifically, the CERCLA Baseline Risk Assessment did not identify any adversely impacted receptors from the current groundwater concentrations. The only possibility of adversely impacting a receptor in the future would be the highly unlikely situation where impacted groundwater were used as a drinking water source. The Baseline Risk Assessment determined that site specific conditions made this potential extremely unlikely. Existing institutional controls would restrict the use of the groundwater as a water source over which time natural attenuation is expected to substantially improve groundwater quality. Additional institutional controls, including deed restriction and monitoring, provide additional redundant backup controls to prevent the use of the impacted groundwater as a water source. In addition, USEPA would evaluate the groundwater quality improvements from natural attenuation in five years pursuant to CERCLA Section 121(c).

Compliance with ARARs - This alternative would comply with all ARARs as described below. Potential chemical-specific, location-specific and action-specific ARARs were identified in Section 2 of this report.

Chemical specific ARARs for this alternative include the Michigan Environmental Response Act (Act 307), RCRA Groundwater Protection Standards and Michigan Water Quality Standards. This alternative would not immediately meet Act 307 requirements for a Type B cleanup, but may do so in the future. This alternative would immediately meet requirements for a Type C cleanup which is documented in Appendix K. RCRA Groundwater Protection Standards would be addressed by establishing ACLs and a monitoring program as part of the RD for this alternative. Corrective action measures would be evaluated and undertaken consistent with RCRA ACL guidance if ACLs were exceeded. Michigan Water Quality Standards would be met since modeling in the Baseline

Risk Assessment determined that no measurable impact to surface water quality would be caused by the groundwater discharge at current concentrations.

USEPA has indicated that ACLs should only be used when cleanup to ARARs is not practicable. However, a RCRA ACL is an ARAR in compliance with RCRA under CFR Section 264.94(b). This section states that "The Regional Administrator will establish an alternative concentration limit for a hazardous constituent if he finds that the constituent will not pose a substantial present or potential hazard to human health or the environment as long as the alternate concentration limit is not exceeded." In addition, in the Preamble to the NCP, USEPA defines the site specific determination of whether treatment is "practicable" as including cost effectiveness, implementability, long term effectiveness and other criteria evaluated in this section of the FS. See 55 Federal Register 8729 (Thursday, March 8, 1990). Natural attenuation, or any other alternative used at this site may or may not eventually achieve RCRA MCLs. However, the attainment of RCRA MCLs is also not a practicable RAO at this site for several reasons:

- 1) The future use of the groundwater at this site for drinking water is extremely unlikely. The location of this site in an industrial section of the City of Kalamazoo where city water is supplied, makes the potential for future groundwater use as drinking water unrealistic. The RCRA MCLs are intended to protect groundwater as a potential drinking water source. Due to site specific conditions, remediation of the impacted groundwater at this site for potential drinking water use is not warranted (see discussion in Section 2.5.1).
- 2) All substantive RCRA ACL requirements are already being met at the site with no adverse impact to receptors as determined in the CERCLA Baseline Risk Assessment for groundwater at current concentrations.

- 3) All sources of groundwater contamination from operations at this site have either been removed in the surface removal action or will be removed during the soil excavation under the Operable Unit I Remedial Action.
- 4) After the only remaining source of groundwater contamination from the site is eliminated under Operable Unit I, the groundwater quality is expected to substantially improve due to natural attenuation.
- 5) Following completion of OUI source removal, and so long as ACLs are not exceeded, an active groundwater system would provide little additional level of protection. Both types of alternatives are expected to take equivalent time periods to implement with the same results (see Appendix F). An active pump and treatment system would not be cost effective or more likely to achieve RCRA MCLs than natural attenuation. Further, active remediation will require the use of large amounts of energy and natural resources with questionable corresponding benefits.
- 6) Even if used in the future, the small volume of impacted groundwater would preclude a long term exposure to a drinking water receptor.
- 7) Background concentrations of several contaminants, including sodium, appear to be high enough to exclude the use of this groundwater as a drinking water source even if all groundwater impacts from the Auto Ion site were remediated.
- 8) As described in Section 1.3, other continuing off-site sources of groundwater contamination may exist which could impede the improvement of groundwater quality.

Site specific conditions meet other CERCLA guidance requirements for the use of ACLs as described below:

- The groundwater has known or projected points of entry into surface water, which is a reasonable distance from the facility boundary. - Impacted groundwater from the site discharges into the Kalamazoo River immediately adjacent to the site (see Section 1.2.6.2). There is no intervening property which would not be subject to institutional controls placed on this site.
- There will be no statistically significant increase at the 95 percent confidence level of constituent concentrations occurring in the surface water in the discharge zone or at any point where constituents are expected to accumulate. - There would not be any significant increases in the river from the groundwater discharge as determined in the Baseline Risk Assessment (see Section 1.2.6.2).
- Institutional controls will be implemented that will preclude human exposure to groundwater contaminants between the facility boundary and the point of entry into the surface water. - Institutional controls are already in place which would preclude human exposure to the groundwater at any location, as previously discussed in this section.
- ACLs should be used only if there is no significant degradation of uncontaminated groundwater before discharge to surface water occurs. - The impacted groundwater is already discharging to the river. No area of uncontaminated groundwater would be adversely impacted by the continued discharge.

No location-specific ARARs would apply to this alternative since no use or development of the site property, other than monitoring, would be undertaken.

No action-specific ARARs would apply to this alternative since no actions, other than monitoring, would be undertaken.

Long-Term Effectiveness and Permanence - Even if no further remedial action is taken, natural attenuation of groundwater constituents would remain at concentrations not unlike those found in the site vicinity given a sufficient period of time for attenuation to occur. Existing institutional controls are more than adequate to assure that the groundwater would not be used as a water source in the foreseeable future. Even without the existence of these controls, the probability of this groundwater being used in the foreseeable future would be extremely remote since city drinking water is supplied to the site and surrounding area. CERCLA's requirement to re-evaluate site conditions at subsequent five year intervals in the future and the ACL monitoring program would also assure that completion of natural attenuation is occurring.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Natural attenuation would result in a reduction of toxicity, mobility and volume through an improvement in the quality of groundwater, but not by using active treatment.

Natural attenuation would include natural biodegradation of organic constituents. The organic constituents present (VOCs) are subject to natural biodegradation which could result in the elimination (reduction of toxicity, mobility and volume) of these compounds over time. The period of time required for this natural process to occur is currently unknown. In Section 1.2.4.2 of this report, parent and biological breakdown products of chlorinated VOCs were identified in the groundwater as evidence of the occurrence of this process. It appears that concentrations of breakdown products have been increasing as parent compound concentrations decrease over time. Nevertheless, several chlorinated hydrocarbons present are known to be resistant to biodegradation; thus it is unlikely that all organic compounds present would be degraded.

Natural attenuation would remove inorganic analytes from groundwater and result in decreasing them by orders of magnitude below hazardous concentrations, reducing toxicity. The mobility and volume of these dilute constituents would be of no environmental concern, since they would not cause any adverse environmental impact.

In summary, the impacted groundwater is expected to dissipate and/or degrade over time due to natural attenuation. Although this is not an artificial treatment process, the toxicity, mobility and volume of the impacted groundwater is expected to be eliminated. This natural process will not have any significant adverse impacts on human health and the environment from current groundwater concentrations as discussed in the CERCLA Baseline Risk Assessment.

Short-Term Effectiveness - Existing institutional controls and site specific conditions are adequate to restrict any potential development of groundwater as a water source during the remedial time frame as previously discussed in this section. The only individuals who would come in contact with the impacted groundwater would be samplers; this activity would be conducted under a health and safety plan (HASP) developed in the remedial design (RD) phase. No adverse environmental impacts would occur. It is estimated that it would take approximately 50 to 60 years for natural attenuation to potentially achieve MDNR Type B cleanup levels (see Appendix F). It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternative due to site geology and the retardation factors of some of the groundwater constituents. MDNR Type C cleanup levels are already being met as documented in Appendix K.

Implementability - This alternative is implementable. Natural attenuation is already occurring at the site. Many of the institutional controls are already in place. There are no problems or difficulties expected in obtaining a deed restriction, developing ACLs and initiating a monitoring program.

Due to the complex nature of variable groundwater flow direction at the site and the possible existence of other continuing off-site sources, the ability to accurately monitor the impact of the alternative on groundwater quality is questionable. Due to the presence of nearby industrial activities that may have resulted in, and may still be resulting in, releases of contaminants, groundwater quality below the Auto Ion site may be affected by upgradient sources. In addition, the seasonal flux of water seepage into the site from the river may impact site groundwater. During the monitoring program, seasonal variations and potential migration of contaminants from upgradient sources should be recorded. However, since there are no receptors, this would not increase the potential for any adverse risk.

Cost - The registering of a deed restriction, development of ACLs and development of a monitoring program is estimated to incur an initial cost of \$210,000. The monitoring program is estimated to incur an annual operation and maintenance (O & M) cost of \$21,700. The present worth including capital and O & M costs, is estimated to be \$565,000, based on a 30 year estimate. A breakdown of the costs associated with this alternative are provided in Table 7-1.

Following the development of the present worth of this alternative, a cost sensitivity analysis was performed. This included an analysis of the assumptions that had been made as part of the development of this alternative. The two most significant items affecting the present worth are: 1) the duration of the project; and, 2) the annual O&M monitoring costs. As discussed previously, the duration of this project cannot be predicted with certainty. We have assumed a 30 year duration in accordance with USEPA guidance for comparison purposes. However, to estimate the remedial action cost from the most conservative viewpoint, it was determined from a present worth financial analysis that present

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TABLE 7-1

FEASIBILITY STUDY FOR
OPERABLE UNIT II
ALTERNATIVE 2 - BREAKDOWN OF ESTIMATED COSTS

I. Capital Costs	
Develop ACLs	\$200,000
Deed Restrictions	<u>10,000</u>
Total Capital Costs	\$210,000
II. O & M Costs (Annual)	
Personnel	\$14,300
Laboratory	6,900
Validation	<u>1,500</u>
Total O & M Costs	\$21,700
III. Present Worth of Alternative (Assume 5% interest @ 30 years; Present Worth Factor (PWF) = 16.374)	
Total Capital Costs	\$210,000
PW = Total O&M Costs (Annual) x PWF	
PW = 21,700 x 16.374 =	<u>\$355,000</u>
Present Worth of Alternative	\$565,000

worth cost would not increase significantly after approximately 60 years, which would increase the alternatives cost by approximately 20%. The groundwater monitoring estimates reflect the actual cost to perform the work, based on Eder Associates' current rates and quotations from a local laboratory. Because these items are based on hard number quotations, little change in the present work resulted from the sensitivity analysis of these items.

7.4.3 Alternative 5 - Groundwater Containment via Low Flow Extraction/Metals Treatment/Filtration/Discharge to a POTW

7.4.3.1 Description of Alternative 5

This alternative is both a containment and treatment alternative involving managing the groundwater gradient to prevent groundwater from migrating off-site and treating the collected water. The groundwater gradient would be managed by extracting enough groundwater to lower the gradient at site locations which would contain the groundwater on-site. This extraction system may or may not be capable of recovering some impacted groundwater which may have previously migrated off-site due to variable east-west gradient groundwater flow directions. The feasibility of collecting off-site groundwater would be assessed in the remedial design phase. The extracted groundwater would be pre-treated on-site if required to meet pre-treatment standards and discharged to the city sanitary sewer for final treatment at the City of Kalamazoo's POTW.

It has been determined that the impacted groundwater from the Auto Ion site can be treated at the Kalamazoo City POTW. The Auto Ion site is serviced by an existing sanitary sewer which would allow the discharge of the site groundwater to be exempt from any applicable RCRA requirements pursuant to the Domestic Sewage Exclusion. See 40 CFR 261.4(a)(1). The POTW has expressed a willingness to accept the wastewater if it meets its pre-treatment requirements. The POTW is in compliance with the Clean Water Act and other applicable laws. The POTW's treatment system can properly handle and

treat the anticipated quantity and quality of the discharge without modifications to existing treatment process. The discharge would be in compliance with all federal, state, and local laws and ordinances, including the POTW's NPDES permit and pre-treatment limitations.

Preliminary extraction flow rates have been estimated for this alternative in the range of approximately 5 to 20 gpm (see Appendix I). The extraction system would be designed as part of the RD for this alternative. Additional quantitative hydrogeological data such as variable site flow conditions and vertical and horizontal hydraulic conductivity would be necessary to complete the design developed in the RD Phase. The design would utilize subsurface drains and/or extraction wells to extract groundwater. Depending on hydraulic conductivities it may also include a hanging barrier wall to reduce river infiltration. For comparative cost purposes, this study will assume that three extraction wells would need to be installed. The actual design developed in the RD phase may include a barrier wall.

After implementation of Operable Unit I, groundwater may meet pretreatment requirements. However, for the purpose of this evaluation, it is assumed, for conservative purposes, that previously measured groundwater concentrations will be present and will exceed the City of Kalamazoo's pretreatment requirements. It would be necessary to treat the groundwater for some metals (e.g. lead, mercury and nickel) prior to discharge to the city sanitary sewer system. It is important to note that after the implementation of Operable Unit I source remediation and continued natural attenuation, that groundwater may not exceed pre-treatment limits. Pretreatment of the groundwater would not be conducted if groundwater quality meets pretreatment requirements or a waiver is obtained. The groundwater may need to undergo filtration prior to metals treatment to remove solids which could adversely effect the metals treatment process.

Metals treatment would consist of either ion exchange or flocculation/precipitation/sedimentation. To determine the most effective treatment process would require additional information from on-site pumping tests to better define water quality. A treatability study may also be necessary. This information would be obtained

during the RD for this alternative. For comparative cost purposes, this study will assume the use of on-site flocculation/precipitation/sedimentation for metals treatment. Residual sludges from the pre-treatment system would be disposed at a landfill in compliance with all applicable disposable requirements.

To assure compliance with pretreatment requirements for the discharge of solids into the sanitary sewer system it may be necessary to filter the treated water prior to discharge. The pre-treated groundwater would then be discharged to the sanitary sewer. The city POTW would treat the groundwater for metals, cyanide and organics.

A groundwater monitoring program would be implemented to assure that impacted groundwater is being contained on-site (using elevation measurements) and to document the reduction in groundwater constituents (using chemical analysis). The groundwater monitoring program would involve quarterly sampling during the first year and thereafter semi-annual sampling for constituents previously identified in the groundwater. Approximately three new monitoring wells would be installed. These wells would assist in characterizing background quality. During the first year, groundwater elevation from all wells and the river would be measured at least once a month. The elevations in selected wells would be measured continuously with remote chart recorders in order to better define groundwater flow conditions. This information would also be used to more accurately estimate the time for one pore volume to be flushed. The monitoring program would last for the time required to flush one pore volume which may be less than the current estimate of five years.

This alternative already meets Michigan Act 307 Type C cleanup criteria, as documented in Appendix L. It may be possible to eventually achieve concentrations which meet a Type B cleanup criteria, although this cannot be determined with any certainty at this time. It is estimated that this extraction/treatment system would remove one pore volume of groundwater in approximately two years. Although this groundwater extraction rate would be approximately three times higher than the natural attenuation discharge rate,

this alternative is not expected to improve groundwater quality any faster than natural attenuation due to the low desorption rates of metal constituents (discussed in Section 7.3 and Appendix F), the effect of possible off-site sources of contamination, and the extraction of river water along with the groundwater. The increased extraction rate, compared to natural attenuation, would increase groundwater and river water flow through the extraction system; however, due to silt and clay in the sand formation, the increase in water volume is not expected to result in an equivalent increase in extraction of groundwater constituents from the aquifer. The desorption rates of the metals would be expected to be the primary controlling factor. It is estimated that, in implementing this alternative, it would take approximately 50 to 60 years to potentially achieve MDNR Type B cleanup levels - the same amount of time required for natural attenuation to achieve a similar result (see Appendix F). This is in addition to the initial five year monitoring phase. It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternatives. The feasibility of achieving Type B cleanup levels is dependent on the ability of the extraction system to recover impacted groundwater and remove constituents to this level before encountering an asymptotic point at which further reduction in groundwater constituent concentrations is not technically achievable.

Based on several uncertainties related to the extent of impacted groundwater (including the implementation of Operable Unit I source removal), as discussed in Sections 1.3 and 5.0, the implementation of this active groundwater remediation alternative would be postponed approximately five years. This is the period of time required for one pore volume of groundwater to be flushed through the site during which time a trend of decreasing constituent concentrations should be apparent if natural attenuation is effectively remediating the groundwater. During the first year the estimated time required to flush one pore volume of groundwater would be refined. Based on that estimate, a pore volume may be flushed in less than 5 years which would, in turn, shorten the monitoring period. During this period, the impact of operable Unit I on groundwater would be evaluated and groundwater monitoring would be used to attempt to resolve other uncertainties such as background groundwater quality. Based on the results of this monitoring it may be

determined that active remediation would provide no benefit in reducing the time frame required for remediation of the impacted groundwater or that active treatment of the groundwater is not practicable unless continuing off-site sources of groundwater contamination are eliminated.

This alternative includes existing institutional controls which would prevent the groundwater from being used as a water source during the period required to remediate the groundwater. City water is already supplied to this area and the installation of new wells is restricted by the state and county health departments. Only the City of Kalamazoo would be able to obtain a permit to install a well in this area in the event that it needed to expand groundwater production for the current water supply system. The city uses a series of criteria to select new well sites. The first criteria is the absence of any potential source of groundwater contamination in the area, which includes a review of all industrial facilities, CERCLA, and state superfund sites. The City would not develop the groundwater in this area due to other adjacent sites of known contamination, the presence of active industrial facilities and the elevated concentrations of sodium, even if the Auto Ion site were not present. All future expansion plans for wells by the city water department are in the outlying township areas, away from the city where the site is located. The State of Michigan also restricts the installation of drinking water wells within the 100 year floodplain. Any drinking water well must have a sloping ground surface, at least 50' in diameter, away from the well and above the 100 year floodplain. The Auto Ion site is in the 100 year floodplain.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the removal of all materials left on the surface of the site that could have been a source of groundwater contamination. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils. This will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site.

As discussed in Section 1.3 of this report, there may be multiple off-site continuing sources of groundwater contamination inhibiting attainment of Michigan Act 307 Type B cleanup criteria, also making active treatment of groundwater impracticable.

It is possible that the extraction system may be incapable of removing low concentrations of residuals with high retardation factors, especially metals, in the groundwater system. Current USEPA studies indicate that groundwater extraction systems are usually not capable of achieving very low cleanup levels (USEPA 1989, Evaluation of Groundwater Extraction Remedies: Volume 1 - Summary Report, OERR, EPA 5402-89054).

This alternative includes an approximately five year implementation delay and the extraction and treatment of groundwater at a minimum extraction flow rate. This approach is consistent with the NCP. The Preamble to the NCP states that response actions which take long periods of time to implement are acceptable if no receptors are being adversely impacted. See 55 Federal Register 8734 (Thursday, March 8, 1990). The CERCLA Baseline Risk Assessment determined that no groundwater receptors, including the river, are being adversely impacted from current groundwater concentrations at the Auto Ion site.

7.4.3.2 Assessment of Alternative 5

Overall Protection of Human Health and the Environment - This alternative is protective of human health and the environment given that no receptors are currently being adversely impacted by groundwater at the site. Specifically the CERCLA Baseline Risk Assessment did not identify any existing receptors, including the river, which are adversely impacted from current groundwater concentrations. The only possibility of adversely impacting a receptor in the future would be the highly unlikely situation where impacted groundwater were used as a drinking water source. The Baseline Risk Assessment determined that site specific conditions made this potential extremely unlikely. Existing institutional controls would restrict the use of the groundwater as a water source over which time the extraction/treatment system is expected to substantially improve groundwater quality.

Compliance with ARARs - This alternative would comply with all ARARs as described below. Potential chemical-specific, location-specific and action-specific ARARs were identified in Section 2 of this report.

Chemical specific ARARs for this alternative include the Michigan Environmental Response Act (Act 307), RCRA Groundwater Protection Standards and Michigan Water Quality Standards. This alternative already meets Act 307 requirements as a Type C cleanup as documented in Appendix L. This alternative may also be capable of meeting Act 307 Type B cleanup criteria, although this cannot be determined without certainty at this time. RCRA Groundwater Protection Standards would be addressed by containing impacted groundwater on-site and extracting and treating the groundwater. Any impacted off-site groundwater which may not be recovered would be addressed by developing RCRA ACLs and implementing a groundwater monitoring program to insure compliance with the ACLs in the same manner as Alternative 2. Michigan Water Quality Standards would be met since no impacted groundwater would be discharged from the site without adequate treatment. For any off-site groundwater which is impacted and would not be contained, the water quality standards would be met since the Baseline Risk Assessment modeling determined that no measurable impact to surface water quality would be caused by the groundwater discharge.

All location-specific ARARs that would pertain to this alternative would be complied with including, the Administrative Order on Floodplain Management, the Clean Water Act, Michigan Act 64, the Natural River Act of 1970, the Shorelands Protection and Management Act of 1970, the Soil Erosion and Sedimentation Control Act, and the Water Resources Commission Act Part 13. The on-site extraction and treatment system can be easily installed and maintained in compliance with these ARARs.

All action-specific ARARs that would pertain to this alternative would be complied with including, RCRA, OSHA, Hazardous Materials Transportation Regulations, Michigan Environmental Response Act, Michigan Act 64, Michigan OSHA, and the Soil Erosion and

Sedimentation Control Act. The proposed on-site treatment is relatively simplistic and could easily be operated in a manner which would assure compliance with these ARARs.

Long-Term Effectiveness and Permanence - The extraction and treatment system may be capable of removing all concentrations of constituents above Michigan Act 307 Type B cleanup criteria. The small volume of impacted groundwater and extremely unlikely potential for future development as a water source result in no significant future risk from groundwater even if the Act 307 Type B levels are not achieved. Many organic compounds and cyanide would be permanently destroyed by biological treatment at the POTW. Metals would be concentrated in on-site and POTW treatment residues (sludges). The concentrated metal residues would be ultimately disposed of in a secure landfill facility. Although a landfill represents a potential future environmental risk, it is the best available technology for the disposal of small volumes of concentrated metal residues.

For any impacted off-site groundwater, from the Auto Ion site, which would not be recovered by the extraction system, natural attenuation would occur and no constituents would be expected to remain at concentrations not unlike those found in the site vicinity given a sufficient period of time for attenuation to occur. Existing institutional controls are more than adequate to assure that the groundwater would not be used as a water source in the foreseeable future. Even without the existence of these controls, the probability of this groundwater being used in the foreseeable future would be extremely remote since city water is supplied to the site and surrounding area and the area groundwater is generally unfit for consumptive uses.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Many organic compounds and cyanide would be permanently destroyed by biological treatment at the POTW. Metals would be concentrated in on-site and POTW treatment residues (sludges). Therefore, this treatment alternative would reduce toxicity, mobility and volume of most organic and cyanide compounds, it would reduce both the mobility and volume for most metals of concern in the groundwater.

For any impacted off-site groundwater which would not be recovered by the extraction system, natural attenuation processes would result in a reduction of toxicity, mobility and volume through an improvement in the quality of groundwater, but not by using active treatment. Natural attenuation would include natural biodegradation of organic constituents. The organic constituents present (VOCs) are subject to natural biodegradation which could result in the elimination (reduction of toxicity, mobility and volume) of these compounds over time. The period of time required for this natural process to occur is currently unknown. In Section 1.2.4.2 of this report, parent and biological breakdown products of chlorinated VOCs were identified in the groundwater as evidence of the occurrence of this process. It appears that concentrations of breakdown products have been increasing as parent compound concentrations decrease over time. However, several chlorinated hydrocarbons present are known to be resistant to biodegradation; thus, it is unlikely that all organic compounds present would be degraded.

Natural attenuation would remove inorganic analytes and recalcitrant organic compounds from groundwater and result in decreasing them by orders of magnitude below hazardous concentrations, reducing toxicity. The mobility and volume of these dilute constituents would be of no environmental concern, since they would not cause any adverse environmental impact.

Short-Term Effectiveness - Existing institutional controls and site specific conditions are adequate to restrict any potential development of groundwater as a water source during the remedial time frame as previously discussed in this section. The only individuals who would come in contact with the impacted groundwater would be site workers; site activity would be conducted under a HASP developed during the RD phase. No adverse environmental impacts would occur.

Although this alternative involves the active extraction of groundwater, it is not expected to be capable of achieving Michigan Act 307 Type B cleanup criteria any sooner than natural attenuation (see Appendix F). It is important to note that this or any other

alternative may not be capable of achieving Type B cleanup levels at all. As discussed in Section 7.3 and Appendix F, the extraction of an increased volume of groundwater is not proportional to the amount of groundwater constituents removed from the aquifer. The retardation factor of constituents, especially for metals, appears to be the controlling factor which determines the amount of constituents removed rather than the volume of groundwater extracted. It has been determined that because of the presence of clay and silts throughout the aquifer at the site, natural attenuation and active pump and treatment alternatives would require essentially the same time period to implement (see Appendix F).

The presence of the river would also limit the amount of groundwater extracted from the aquifer. River water would be extracted along with the groundwater, decreasing the volume of impacted groundwater extracted, under virtually any active extraction scenario. It is estimated that it would take approximately 50 to 60 years to potentially achieve MDNR Type B cleanup levels - the same amount of time required for natural attenuation. It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternatives due to site geology and the retardation factors of some of the groundwater constituents.

Implementability - This alternative is implementable. The construction of the extraction system and on-site treatment system would utilize readily available technologies. The site is already serviced by a sanitary sewer to the city POTW which can readily accept the proposed discharge. If the extraction system is determined to be incapable of removing low levels of certain constituents, natural attenuation can be readily implemented as previously discussed in this section.

Since the site is adjacent to the river, a large volume of river water would be included in the extracted groundwater. This would reduce the number of pore volumes removed from the impacted groundwater. For every gallon of river water extracted, one less gallon of impacted groundwater would be extracted and treated. Increasing extraction rates would increase the volume of river water extracted. This would also decrease the potential for this

alternative to achieve Michigan Act 307 Type B cleanup criteria any sooner than natural attenuation.

Due to the complex nature of variable groundwater flow direction at the site and the possible existence of other continuing off-site sources, the ability to accurately monitor the impact of the alternative on groundwater quality is questionable. However, since there are no receptors, this would not increase the potential for any adverse risk.

Cost - At a 20 gpm flow rate, the extraction and treatment system would result in a capital cost of approximately \$635,000. The estimated annual O & M cost is \$391,000. The present worth for this alternative, including capital and O & M costs, is estimated to be \$5,650,000 based on a 30 year estimate. A breakdown of the costs associated with this alternative are provided in Table 7-2. Table 7-2 also provides a cost estimate for the low flow (5 gpm) scenario for comparison purposes.

Following the development of the present worth of this alternative, a cost sensitivity analysis was performed. This included an analysis of the assumptions that had been made as part of the development of this alternative. The two most significant items affecting the present worth are: 1) the duration of the project; and, 2) the annual O&M monitoring costs. As discussed previously, the duration of this project cannot be predicted with certainty. We have assumed a 30 year duration in accordance with USEPA guidance for comparison purposes. However, to estimate the remedial action cost from the most conservative viewpoint, it was determined from a present worth financial analysis that present worth cost would not increase significantly after 60 years, which would increase the alternative cost by approximately 20%. The annual O&M monitoring costs are primarily affected by the cost of the plant operators, the POTW charges and the groundwater monitoring cost. The operator costs are based on an estimate of the effort which would be required to keep the plant operating and to perform the preventative maintenance tasks. The POTW charges are based on rates provided in the City of Kalamazoo's sewer ordinance. The groundwater monitoring estimates reflect the actual cost to perform the work, based on Eder Associates'

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TABLE 7-2

FEASIBILITY STUDY FOR
OPERABLE UNIT II
ALTERNATIVE 5 - BREAKDOWN OF ESTIMATED COSTS

I. Capital Costs	<u>5 GPM</u>	<u>20 GPM</u>
** Develop ACLs	100,000	100,000
* Extraction Wells (3)	6,500	6,500
* Piezometer Wells (6)	13,000	13,000
** Gradient Control/Logic System	20,000	20,000
* Pretreatment System	66,290	132,580
*** HVAC/Utilities	21,200	42,400
*** Building/Site Preparation	<u>45,665</u>	<u>91,330</u>
Subtotal	\$273,000	\$406,000
** Engineering Costs	78,400	98,400
** Contingency Costs	<u>105,000</u>	<u>131,000</u>
Total Capital Costs	\$456,000	\$635,000
II. O & M Costs (Annual)	<u>5 GPM</u>	<u>20 GPM</u>
** Utilities	6,000	12,000
** Treatment Reagents	2,628	10,500
** Treatment Residue Disposal	14,652	58,500
** Plant Operators	41,600	83,200
** Discharge Monitoring	6,960	6,960
**** POTW Charges	<u>32,526</u>	<u>129,957</u>
Subtotal	\$10,400	\$301,000
** Engineering Costs	10,400	30,100
** Contingency Costs	<u>20,900</u>	<u>60,200</u>
Total O & M Costs (Annual)	\$135,000	\$391,000

Table 7-2 Continued...

III. **Monitoring Costs (Annual)	\$26,800	\$26,800
IV. Present Worth of Alternative		
Assume 5 year monitoring delay 30 year operation 5% interest		
<u>1. Present Worth of Capital Costs</u>		
Capital Costs realized in 5 years Present Worth Factor for a Single Payment (P/F) = 0.7835 PW = Capital Costs x (P/F) = PW5 = 456,000 x 0.7835 = 357,000 PW20 = 635,000 x 0.7835 = 498,000		
<u>2. Present Worth of O & M Costs</u>		
O&M Costs to begin in 5 years and last for 30 years Present Worth Factor for a Single Payment (P/F) = 0.7835 Present Worth Factor for a Uniform Series Payment (P/A) = 15.372 PW = O&M costs x P/A x P/F PW5 = 135,000 x 15.372 x 0.7835 = 1,630,000 PW20 = 391,000 x 15.372 x 0.7835 = 4,710,000		
<u>3. Present Worth of Monitoring</u>		
Monitoring will last for 35 years Present Worth Factor for a Uniform Series (P/A) = 16.374 PW = O&M x P/A = PW5 = 26,800 x 16.374 = 439,000 PW20 = 26,800 x 16.374 = 439,000		
<u>4. Present Worth of Alternative</u>		
	<u>5 GPM</u>	<u>20 GPM</u>
PW of Capital Cost	357,000	498,000
PW of O&M Costs	1,630,000	4,710,000
PW of Monitoring Cost	439,000	439,000
PW of Alternative	\$2,430,000	\$5,650,000

current rates and quotations from a local laboratory. Because these major items are either based on published rates or hard number quotations, little change in the present work resulted from the sensitivity analysis of these items.

7.4.4 Alternative 6 - High Flow Groundwater Extraction/Metals Treatment/Filtration/Discharge to a POTW

7.4.4.1 Description of Alternative 6

This alternative is an active groundwater recovery and treatment alternative. The groundwater gradient would be controlled by extracting sufficient groundwater to lower the gradient enough to attempt to recover all groundwater that exceeds Michigan Act 307 Type B cleanup criteria from Auto Ion operations on and off-site. The extracted groundwater would be pre-treated on-site, if required to meet pre-treatment standards, and discharged to the city sanitary sewer for final treatment at the City of Kalamazoo's POTW. This alternative does not rely on natural attenuation.

It has been determined that the impacted groundwater from the Auto Ion site can be treated at the Kalamazoo City POTW. The Auto Ion site is serviced by an existing sanitary sewer which would allow the discharge of the site groundwater to be exempt from any applicable RCRA requirements pursuant to the Domestic Sewage Exclusion. See 40 CFR 261.4(a)(1). The POTW has expressed a willingness to accept the wastewater if it meets its pre-treatment requirements. The POTW is in compliance with the Clean Water Act and other applicable laws. The POTW's treatment system can properly handle and treat the anticipated quantity and quality of the discharge without modifications to existing treatment process. The discharge would be in compliance with all federal, state, and local laws and ordinances, including the POTW's NPDES permit and pre-treatment limitations.

Preliminary extraction flow rates have been estimated for this alternative in the range of approximately 10 to 30 gpm (see Appendix I). The extraction system would be designed

as part of the RD for this alternative. Additional quantitative hydrogeological data such as variable site flow conditions and vertical and horizontal hydraulic conductivity would be necessary to complete the design developed in the RD phase. The design would utilize subsurface drains and/or extraction wells to extract groundwater. Depending on hydraulic conductivities it may also include a hanging barrier wall to reduce river infiltration. For comparative cost purposes, this study will assume that three extraction wells would need to be installed. The actual design developed in the RD phase may include a barrier wall.

After implementation of Operable Unit I, groundwater may meet pretreatment requirements. However, for the purpose of this evaluation, it is assumed, for conservative purposes, that previously measured groundwater concentrations will be present and will exceed the City of Kalamazoo's pretreatment requirements. It would be necessary to treat the groundwater for some metals (e.g. lead, mercury and nickel) prior to discharge to the city sanitary sewer system. It is important to note that after the implementation of Operable Unit I source remediation and continued natural attenuation, that groundwater may not exceed pre-treatment limits. Pretreatment of the groundwater would not be conducted if groundwater quality meets pretreatment requirements or a waiver is obtained. The groundwater may need to undergo filtration prior to metals treatment to remove solids which could adversely effect the metals treatment process.

Metals treatment would consist of either ion exchange or flocculation/precipitation/sedimentation. To determine the most effective treatment process would require additional information from on-site pumping tests to better define water quality. A treatability study may also be necessary. This information would be obtained during the RD for this alternative. For comparative cost purposes, this study will assume the use of on-site flocculation/precipitation/sedimentation for metals treatment. Residual sludges from the pretreatment system would be disposed at a landfill in compliance with all applicable disposal requirements.

To assure compliance with pretreatment requirements for the discharge of solids into the sanitary sewer system it may be necessary to filter the treated water prior to discharge. The pre-treated groundwater would then be discharged to the sanitary sewer. The city POTW would treat the groundwater for the other metals, cyanide and organics.

A groundwater monitoring program would be implemented to assure that all impacted groundwater is being recovered (using elevation measurements) and to document the reduction in groundwater constituents (using chemical analysis). The groundwater monitoring program would involve quarterly sampling during the first year and thereafter semi-annual sampling for constituents previously identified in the groundwater. Approximately three new monitoring wells would be installed. These wells would assist in characterizing background quality. During the first year groundwater elevations from all wells and the river would be measured at least once a month. The elevations in selected wells would be measured continuously with remote chart recorders in order to better define groundwater flow conditions; This information would also be used to more accurately estimate the time for one pore volume to be flushed. The monitoring program would last for the time required to flush one pore volume which may be less than the current estimate of five years.

This alternative would attempt to meet Michigan Act 307 Type B criteria, although it cannot be determined with certainty whether Type B criteria are achievable. It is estimated that this extraction/treatment system would remove one pore volume in approximately one year.

Although this groundwater extraction rate would be approximately six times higher than the natural attenuation discharge rate, this alternative is not expected to improve groundwater quality any faster than natural attenuation due to the low desorption rates of metal constituents (see Section 7.3 and Appendix F), the effect of possible off-site sources of contamination, and the extraction of river water along with the groundwater. The increased extraction rate would increase groundwater and river water flow through the

extraction system; however, as fully explained in Section 7.3, due to silt and clay in the sand formation the increase in water volume is not expected to result in an equivalent increase in extraction of groundwater constituents from the aquifer. The desorption rates of the metals would be expected to be the primary controlling factor; consequently this would results in essentially the same implementation time frame for this alternative as natural attenuation (see Appendix F). It is estimated that it would take approximately 50 to 60 years to potentially achieve MDNR Type B cleanup levels (see Appendix F). It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternatives. The feasibility of achieving Type B cleanup levels is dependent on the ability of the extraction system to remove constituents to this level before encountering an asymptotic point at which further reduction in groundwater constituent concentrations is not technically achievable.

Based on several uncertainties related to the extent of impacted groundwater (including the implementation of Operable Unit I source removal), as discussed in Section 5.0, the implementation of this active groundwater remediation alternative would be postponed approximately five years. This is the estimated period of time required for one pore volume of groundwater to be flushed through the site during which time a trend of decreasing constituent concentrations should be apparent if natural attenuation is effectively remediating the groundwater. During this period, the impact of operable Unit I groundwater would be evaluated and groundwater monitoring would be used to attempt to resolve these uncertainties such as background groundwater quality. Based on the results of this monitoring it may be determined that, aside from the impact of site geology and the retardation factors as explained in Section 7.3, active remediation is not practicable unless continuing off-site sources of groundwater contamination are eliminated.

This alternative includes existing institutional controls which would prevent the groundwater from being used as a water source during the period required to remediate the groundwater. City water is already supplied to this area and the installation of new water wells is restricted by the state and county health departments. Only the City of Kalamazoo

would be able to obtain a permit to install a water well in this area in the event that it needed to expand groundwater production for the current water supply system. The city uses a series of criteria to select new well sites. The first criteria is the absence of any potential source of groundwater contamination in the area, which includes a review of all industrial facilities, CERCLA, and state superfund sites. The City would not develop the groundwater in this area due to other adjacent sites of known contamination, the presence of active industrial facilities and the elevated concentrations of sodium, even if the Auto Ion site were not present. All future expansion plans for wells by the city water department are in the outlying township areas, away from the city where the site is located. The State of Michigan also restricts the installation of drinking water wells within the 100 year floodplain. Any drinking water well must have a sloping ground surface, at least 50' in diameter, away from the well and above the 100 year floodplain. The Auto Ion site is in the 100 year floodplain.

This alternative includes other response actions which have been and are in the process of being implemented. A surface removal action resulted in the removal of all materials left on the surface of the site that could have been a source of groundwater contamination. The Operable Unit I source remedial action will involve the excavation and off-site disposal of several thousand cubic yards of impacted soils. This will eliminate the only remaining source of groundwater contamination from former operations at the Auto Ion site.

As discussed in Section 1.3 of this report, there may be multiple off-site continuing sources of groundwater contamination inhibiting attainment of Michigan Act 307 Type B cleanup criteria, also making active treatment of groundwater impracticable.

It is possible that the extraction system may be incapable of removing low concentrations of residuals with high retardation factors, especially metals, in the groundwater system. Current USEPA studies indicate that groundwater extraction systems are usually not capable of achieving very low cleanup levels (USEPA 1989, Evaluation of

Groundwater Extraction Remedies: Volume 1 - Summary Report, OERR, EPA 5402-89054).

In the event that an asymptotic point of recovery is reached, active extraction of the groundwater would be terminated and natural attenuation would be utilized to complete the groundwater remediation.

This alternative includes an approximately five year implementation delay. This approach is consistent with the NCP. The Preamble to the NCP states that response actions which take long periods of time to implement are acceptable if no receptors are being adversely impacted. See 55 Federal Register 8734 (Thursday, March 8, 1990). The CERCLA Baseline Risk Assessment determined that no groundwater receptors, including the river, are being adversely impacted from current groundwater concentrations at the Auto Ion site.

7.4.4.2 Assessment of Alternative 6

Overall Protection of Human Health and the Environment - This alternative is protective of human health and the environment given that no receptors are currently being adversely impacted by groundwater at the site. Specifically, the CERCLA Baseline Risk Assessment did not identify any existing receptors, including the river, which are adversely impacted from current groundwater concentrations. The only possibility of adversely impacting a receptor in the future would be the highly unlikely situation where impacted groundwater were used as a drinking water source. The Baseline Risk Assessment determined that site specific conditions made this potential extremely unlikely. Existing institutional controls would restrict the use of the groundwater as a source over which time the extraction/treatment system is expected to substantially improve groundwater quality.

Compliance with ARARs - This alternative would comply with all ARARs as described below. Potential chemical-specific, location-specific and action-specific ARARs were identified in Section 2 of this report.

Chemical specific ARARs for this alternative include the Michigan Environmental Response Act (Act 307), RCRA Groundwater Protection Standards and Michigan Water Quality Standards. This alternative would meet Act 307 requirements as a Type C cleanup. This alternative would also attempt to achieve Act 307 Type B cleanup criteria, although it cannot be determined with certainty whether Type B criteria are achievable. The feasibility of achieving Type B cleanup levels is dependent on the ability of the extraction system to remove constituents to this level before encountering an asymptotic point at which further reduction in groundwater constituent concentrations is not technically achievable. RCRA Groundwater Protection Standards would be addressed by extracting and treating the impacted groundwater. Michigan Water Quality Standards would be met since no impacted groundwater would be discharged from the site without adequate treatment.

All location-specific ARARs that would pertain to this alternative would be complied with including, the Administrative Order on Floodplain Management, the Clean Water Act, Michigan Act 64, the Natural River Act of 1970, the Shorelands Protection and Management Act of 1970, the Soil Erosion and Sedimentation Control Act, and the Water Resources Commission Act Part 13. The on-site extraction and treatment system can be easily installed and maintained in compliance with these ARARs.

All action-specific ARARs would be complied with including, RCRA, OSHA, Hazardous Materials Transportation Regulations, Michigan Environmental Response Act, Michigan Act 64, Michigan OSHA, and the Soil Erosion and Sedimentation Control Act. The proposed on-site treatment is relatively simplistic and could easily be operated in a manner which would assure compliance with these ARARs.

Long-Term Effectiveness and Permanence - The extraction and treatment system may be capable of removing all concentrations of constituents above Michigan Act 307 Type B cleanup criteria. The small volume of impacted groundwater and extremely unlikely potential for future development as a water source result in no significant future risk from groundwater even if the Act 307 Type B levels are not achieved. Many organic compounds

Chemical specific ARARs for this alternative include the Michigan Environmental Response Act (Act 307), RCRA Groundwater Protection Standards and Michigan Water Quality Standards. This alternative would meet Act 307 requirements as a Type C cleanup. This alternative would also attempt to achieve Act 307 Type B cleanup criteria, although it cannot be determined with certainty whether Type B criteria are achievable. The feasibility of achieving Type B cleanup levels is dependent on the ability of the extraction system to remove constituents to this level before encountering an asymptotic point at which further reduction in groundwater constituent concentrations is not technically achievable. RCRA Groundwater Protection Standards would be addressed by extracting and treating the impacted groundwater. Michigan Water Quality Standards would be met since no impacted groundwater would be discharged from the site without adequate treatment.

All location-specific ARARs that would pertain to this alternative would be complied with including, the Administrative Order on Floodplain Management, the Clean Water Act, Michigan Act 64, the Natural River Act of 1970, the Shorelands Protection and Management Act of 1970, the Soil Erosion and Sedimentation Control Act, and the Water Resources Commission Act Part 13. The on-site extraction and treatment system can be easily installed and maintained in compliance with these ARARs.

All action-specific ARARs would be complied with including, RCRA, OSHA, Hazardous Materials Transportation Regulations, Michigan Environmental Response Act, Michigan Act 64, Michigan OSHA, and the Soil Erosion and Sedimentation Control Act. The proposed on-site treatment is relatively simplistic and could easily be operated in a manner which would assure compliance with these ARARs.

Long-Term Effectiveness and Permanence - The extraction and treatment system may be capable of removing all concentrations of constituents above Michigan Act 307 Type B cleanup criteria. The small volume of impacted groundwater and extremely unlikely potential for future development as a water source result in no significant future risk from groundwater even if the Act 307 Type B levels are not achieved. Many organic compounds

and cyanide would be permanently destroyed by biological treatment at the POTW. Metals would be concentrated in on-site and POTW treatment residues (sludges). The concentrated metal residues would be ultimately disposed of in a secure landfill facility. Although a landfill represents a potential future environmental risk, it is the best available technology for the disposal of small volumes of concentrated metal residues.

Reduction of Toxicity, Mobility, or Volume Through Treatment - Many organic compounds and cyanide would be permanently destroyed by biological treatment at the POTW. Metals would be concentrated in on-site and POTW treatment residues (sludges). Therefore, this treatment alternative would reduce toxicity, mobility and volume of most organic and cyanide compounds, it would reduce both the mobility and volume for most metals of concern in the groundwater.

Short-Term Effectiveness - Existing institutional controls and site specific conditions are adequate to restrict any potential development of groundwater as a drinking water source during the remedial time frame as previously discussed in this section. The only individuals who would come in contact with the impacted groundwater would be site workers; site activity would be conducted under a HASP developed during the RD phase. No adverse environmental impacts would occur.

Although this alternative involves the active extraction of groundwater, it is not expected to be capable of achieving Michigan Act 307 Type B cleanup criteria any sooner than natural attenuation (see Appendix F). It is important to note that this or any other alternative may not be capable of achieving Type B cleanup levels at all. As discussed in Section 7.3 and Appendix F, the extraction of an increased volume of groundwater is not

proportional to the amount of groundwater constituents removed from the aquifer. The retardation factor of constituents, especially for metals, appears to be the controlling factor which determines the amount of constituents removed rather than the volume of groundwater extracted. It has been determined that because of the presence of clay and silts throughout the aquifer at the site, natural attenuation and active pump and treatment alternatives would require essentially the same time period to implement (see Appendix F).

The presence of the river would also limit the amount of groundwater extracted from the aquifer. River water would be extracted along with the groundwater, decreasing the volume of impacted groundwater extracted, under virtually any active extraction scenario. It is estimated that it would take approximately 50 to 60 years to potentially achieve MDNR Type B cleanup levels - the same amount of time required for natural attenuation. It is important to note that it may be impossible to ever achieve Type B cleanup levels using this or any other remedial alternatives due to site geology and the retardation factors of some of the groundwater constituents.

Implementability - This alternative is implementable. The construction of the extraction system and on-site treatment system would utilize readily available technologies. The site is already serviced by a sanitary sewer to the city POTW which can readily accept the proposed discharge. If the extraction system is determined to be incapable of removing low levels of certain constituents, natural attenuation can be readily implemented as previously discussed in this section.

Since the site is adjacent to the river, a large volume of river water would be included in the extracted groundwater. This would reduce the number of pore volumes removed from the impacted groundwater. For every gallon of river water extracted, one less gallon of impacted groundwater would be extracted and treated. Increasing extraction rates would increase the volume of river water extracted. This would also decrease the potential for this alternative to achieve Michigan Act 307 Type B cleanup criteria any sooner than natural attenuation.

Due to the complex nature of variable groundwater flow direction at the site and the possible existence of other continuing off-site sources, the ability to accurately monitor the impact of the alternative on groundwater quality is questionable. However, since there are no receptors, this would not increase the potential for any adverse risk.

Cost - At a flow rate of 30 gpm, the extraction and treatment system would result in a capital cost of approximately \$557,000. The estimated annual O & M cost is \$514,000. The present worth for this alternative, including capital and O & M costs, is estimated to be \$7,070,000 based on a 30 year estimate. A breakdown of the costs associated with this alternative are provided in Table 7-3. Table 7-3 also provides a cost estimate for the low flow (10 gpm) scenario for comparison purposes.

Following the development of the present worth of this alternative, a cost sensitivity analysis was performed. This included an analysis of the assumptions that had been made as part of the development of this alternative. The two most significant items affecting the present worth are: 1) the duration of the project; and, 2) the annual O&M monitoring costs. As discussed previously, the duration of this project cannot be predicted with certainty. We have assumed a 30 year duration in accordance with USEPA guidance for comparison purposes. However, to estimate the remedial action cost from the most conservative viewpoint, it was determined from a present worth financial analysis that present worth cost would not increase significantly after approximately 60 years, which would increase the alternative cost by approximately 20%. The annual O&M monitoring costs are primarily affected by the cost of the plant operators, the POTW charges and the groundwater monitoring cost. The operator costs are based on an estimate of the effort which would be required to keep the plant operating and to perform the preventative maintenance tasks. The POTW charges are based on rates provided in the City of Kalamazoo's sewer ordinance. The groundwater monitoring estimates reflect the actual cost to perform the work, based on Eder Associates' current rates and quotations from a local laboratory. Because these major items are either based on published rates or hard number quotations, little change in the present work resulted from the sensitivity analysis of these items.

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TABLE 7-3

FEASIBILITY STUDY FOR
OPERABLE UNIT II
ALTERNATIVE 6 - BREAKDOWN OF ESTIMATED COSTS

I. Capital Costs		10 GPM	30 GPM
•	Extraction Wells (3)	6,500	8,500
•	Piezometer Wells (6)	13,000	13,000
**	Gradient Control/Logic System	20,000	20,000
•	Pretreatment System	73,500	147,000
***	HVAC/Utilities	21,200	42,400
***	Building/Site Preparation	<u>45,665</u>	<u>91,330</u>
	Subtotal	\$180,000	\$322,000
**	Engineering Costs	79,480	78,400
**	Contingency Costs	105,973	<u>105,000</u>
			<u>134,446</u>
			<u>134,000</u>
Total Capital Costs		\$366,000	\$456,000
II. O & M Costs (Annual)		10 3 GPM	30 20 GPM
**	Utilities	6,000	12,000
**	Treatment Reagents	5,256	15,768
**	Treatment Residue Disposal	29,304	81,900
**	Plant Operators	41,600	83,200
**	Discharge Monitoring	6,960	9,690
****	POTW Charges	<u>65,052</u>	<u>195,159</u>
	Subtotal	\$154,000	\$395,000
**	Engineering Costs	15,400	39,500
**	Contingency Costs	<u>30,800</u>	<u>79,000</u>
Total O & M Costs (Annual)		\$200,000	\$514,000
III. **Monitoring Costs (Annual)		\$26,800	\$26,800

Table 7-3 Continued...

IV. Present Worth of Alternative

Assume 5 year monitoring delay
30 year operation
5% interest

1. Present Worth of Capital Costs

Capital Costs realized in 5 years
Present Worth Factor for a Single Payment (P/F) = 0.7835
PW = Capital Costs x (P/F) =
PW10 = 366,000 x 0.7835 = 287,000
PW30 = 557,000 x 0.7835 = 436,000

2. Present Worth of O & M Costs

O&M Costs to begin in 5 years and last for 30 years
Present Worth Factor for a Single Payment (P/F) = 0.7835
Present Worth Factor for a Uniform Series Payment (P/A) = 15.372
PW = O&M costs x P/A x P/F
PW10 = 200,000 x 15.372 x 0.7835 = 2,410,000
PW30 = 514,000 x 15.372 x 0.7835 = 6,190,000

3. Present Worth of Monitoring

Monitoring will last for 35 years
Present Worth Factor for a Uniform Series (P/A) = 16.374
PW = O&M x P/A =
PW10 = 26,800 x 16.374 = 439,000
PW30 = 26,800 x 16.374 = 439,000

4. Present Worth of Alternative

	10 5 GPM	30 20 GPM
PW of Capital Cost	287,000	436,000
PW of O&M Costs	2,410,000	6,190,000
PW of Monitoring Cost	<u>439,000</u>	<u>439,000</u>
PW of Alternative	\$3,140,000	\$7,070,000

8.0 Comparative Analysis of Alternatives

8.1 Introduction

This section compares the groundwater remedial alternatives evaluated in Section 7 to each other. The evaluations are arranged in accord with the CERCLA-SARA Criteria. Table 8-1 summarizes the comparison of the four remaining remedial alternatives.

8.2 Overall Protection of Human Health and the Environment

All of the alternatives are protective of human health and the environment given that no receptors are currently being adversely impacted by groundwater at the site. The CERCLA Baseline Risk Assessment determined that the river is not adversely impacted from current groundwater concentrations and use of groundwater is not a realistic future scenario. There is also a concern by the regulatory agencies that the Kalamazoo River may have been adversely impacted in the past by this site; however, it does not appear as though existing groundwater concentrations are having an adverse impact as determined in the Baseline Risk Assessment. Also, as concluded in the March 1993 Sediment Toxicity Evaluation Report, there would not be a measurable effect on water quality due to the large flow in the river as compared to the groundwater flux to the river. The results of the evaluation also support a similar conclusion that there is not discernible impact on the aquatic macroinvertebrate community of the Kalamazoo River. The only differences between the alternatives are measured by other criteria, such as cost. Active remediation alternatives may provide a small level of extra protection with regard to the flow of contaminants to the river via groundwater; however, the marginal increase in protectiveness provided by an active remediation of groundwater would not be cost-effective.

**AUTO ION SITE
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TABLE 8-1

COMPARATIVE EVALUATION OF THE REMEDIAL ALTERNATIVES

CRITERIA	REMEDIAL ALTERNATIVE 1: No Further Action	REMEDIAL ALTERNATIVE 2: Natural Attenuation/ Institutional Controls	REMEDIAL ALTERNATIVE 5: Groundwater Containment Via Low Flow Extraction/Metals Treatment/ Filtration/Discharge to a POTW	REMEDIAL ALTERNATIVE 6: High Flow Groundwater Extraction/ Metals Treatment/Filtration/ Discharge to a POTW
(1) Overall Protection of Public Health and the Environment	Protects human health and the environment. No receptors are adversely impacted. Natural attenuation remediates groundwater.	Protects human health and the environment. No receptors are adversely impacted. Natural attenuation remediates groundwater.	Protects human health and the environment. No receptors are adversely impacted. Groundwater is remediated by pump and treatment system.	Protects human health and the environment. No receptors are adversely impacted. Groundwater is remediated by pump and treatment system.
(2) Compliance with State and Federal Laws and Regulations	Complies with all State and Federal laws and regulations except for monitoring requirements for RCRA ACLs.	Complies with all State and Federal laws and regulations.	Complies with all State and Federal laws and regulations.	Complies with all State and Federal laws and regulations.
(3) Cost	-0-	\$621,000	\$5,650,000	\$7,070,000
(4) Implementability	Not Applicable	Easily Implemented	Installation and operation of system may be difficult due to potential off-site sources and extracted flow from river.	Installation and operation of system may be difficult due to potential off-site sources and extracted flow from river.
(5) Short-term Effectiveness	Not Applicable	No short-term risk.	No adverse environmental impacts during construction and operation.	No adverse environmental impacts during construction and operation.
(6) Long-term Effectiveness	Provides long-term effectiveness due to lack of impacted receptors and groundwater is remediated through natural attenuation.	Provides long-term effectiveness due to lack of impacted receptors and groundwater is remediated through natural attenuation.	Provides long-term effectiveness due to lack of impacted receptors and groundwater is remediated by pump and treatment system. Remedial time frame may not be any sooner than Alternatives 1 and 2.	Provides long-term effectiveness due to lack of impacted receptors and groundwater is remediated by pump and treatment system. Remedial time frame may not be any sooner than Alternatives 1 and 2.
(7) Reduction of Contaminant Toxicity, Mobility, and Volume through Treatment	No treatment method is used. Reduction in toxicity, mobility and volume of impacted groundwater occurs via natural attenuation.	No treatment method is used. Reduction in toxicity, mobility and volume of impacted groundwater occurs via natural attenuation.	Reduction in toxicity, mobility and volume of impacted groundwater occurs via active pump and treatment system.	Reduction in toxicity, mobility and volume of impacted groundwater occurs via active pump and treatment system.
(8) State Acceptance	(1)	(1)	(1)	(1)
(9) Community Acceptance	(1)	(1)	(1)	(1)

(1): To be determined after RI/FS and proposed remedial alternative have undergone public review.

8.3 Compliance with ARARs

All of the alternatives, except Alternative 1 (No Further Action) comply with all ARARs. Alternative 1 does not comply with the RCRA Groundwater Protection Standards because it does not include any development of ACLs or groundwater monitoring program. Alternative 1 complies with all other ARARs.

8.4 Long-Term Effectiveness and Permanence

All alternatives result in attainment of remedial action objectives and provide long term effectiveness and permanence. Alternatives 5 and 6; however, would require the use of additional energy and natural resources and would concentrate metals from the groundwater in sludges which would ultimately be landfilled. The long term risk associated with the landfilling of this small amount of material should be low.

As explained in Section 1.3, there is a possibility that there may be continuing off-site sources of contamination, unrelated to former operations at the site, which may inhibit any of the alternatives from achieving Michigan Act 307 Type B cleanup criteria. Additionally, it may not be feasible to attain Type B criteria due to site geology and the retardation factors of some of the groundwater constituents (see Appendix F). However, this possibility is equal for each of the alternatives and can not be used to differentiate between them.

8.5 Reduction of Toxicity, Mobility, or Volume Through Treatment

Alternatives 5 (Groundwater Containment Via Low Flow Extraction...) and 6 (High Flow Groundwater Extraction...) both achieve equally high levels of reduction in toxicity, mobility and volume through active treatment of inorganic and organic constituents of concern.

Alternatives 1 (No Further Action) and 2 (Natural Attenuation/Institutional Controls) reduce toxicity, mobility and volume of some organics through natural biodegradation. Although these alternatives do not reduce toxicity, mobility, or volume of inorganics and recalcitrant organic compounds through treatment, they result in the removal of the groundwater constituents in a manner which causes no adverse short or long term environmental impacts.

8.6 Short-Term Effectiveness

All alternatives are protective of human health and the environment during the implementation of the remedy given that no receptors are currently being adversely impacted by groundwater at the site. Also, as concluded in the March 1993 Sediment Toxicity Evaluation Report, there would not be a measurable effect on water quality due to the large flow in the river as compared to the groundwater flux to the river. The results of the evaluation also support a similar conclusion that there is no discernible impact on the aquatic macroinvertebrate community of the Kalamazoo River. All alternatives rely on existing institutional controls and existing site conditions (area supplied by city water) as the primary means of controlling use of the groundwater during implementation. All alternatives are expected to take approximately the same time period to implement due to site geology and the retardation factors of some of the groundwater constituents.

Alternative 1 (No Further Action) involves the least human contact with the impacted groundwater. Alternative 2 (Natural Attenuation/Institutional Controls) involves the second least amount of human contact with the impacted groundwater. Alternatives 5 (Groundwater Containment Via Low Flow Extraction...) and Alternative 6 (High Flow Groundwater Extraction...) both involve approximately equivalent levels of human contact with the groundwater which is greater than the other alternatives. The low concentration of constituents of concern in the groundwater and the ability to easily control this contact with a HASP makes the differences in contact insignificant for comparison purposes.

8.7 Implementability

All of the alternatives are implementable relying on existing or readily available processes and/or equipment.

It is possible that the high retardation factors of some of the constituents, especially metals, may cause their desorption rate to be so slow that attainment of Michigan Act 307 Type B cleanup criteria could be delayed indefinitely. However, this possibility is equal among all of the alternatives. The resulting time necessary to complete the remedial action alternatives would be essentially the same as that for Alternatives 1 and 2.

8.8 Cost Effectiveness

Alternative 1 (No Further Action) is the most cost-effective alternative. Alternative 2 (Natural Attenuation/Institutional Controls) is the second most cost-effective alternative.

Alternative 5 (Groundwater containment via Low Flow Extraction ...) and Alternative 6 (High Flow Groundwater Extraction ...) costs are approximately ten and thirteen times higher respectively. However, as explained in Section 7.3 and Appendix F, neither alternative offers any greater protection than Alternatives 1 and 2, while expending additional energy and natural resources.